REPORT OF

TWENTY-FOURTH ANNUAL

DATE GROWERS' INSTITUTE

APRIL 26, 1947

HELD IN

COACHELLA VALLEY

CALIFORNIA

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DATE GROWERS' INSTITUTE

Coachella Valley, California

The Date Institute, a non-profit educational organization devoted to furthering the knowledge of date growing, is in its twenty-fourth year. Proceedings of each Institute have been published, and may be purchased from the secretary in a complete set, or by individual copies.

24th Annual Date Growers' Institute

Saturday, April 26, 1947

Chairman, Morning Session: M. M. Winslow, Director of the Citrus Experiment Station, Riverside
Chairman, Afternoon Session: Dr. Joseph R. Furr, Director of the U. S. Gov't Date Garden, Indio, Calif.

PROGRESS OF WORK ON BEETLE INFESTATION IN DATES

Dwight F. Barnes[1] and D. L. Lindgren[2]

Field studies of the biology and control of nitidulids in dates have been continued since our report to the 1946 meeting of the Date Institute, and several interesting facts have been established. Four species of nitidulids have been found to be abundant. It has been determined that feeding and reproduction of the beetles is continuous throughout the year in the gardens. Preliminary tests with benzene hexachloride to kill larvae as they enter the soil for pupation indicate that it may be useful for this purpose. Tests with soil flooded for five or six days have shown that irrigation water can be used to kill larvae and pupae in the soil.

Insects Usually Found Infesting Dates

The four species of nitidulids most commonly found in dates are the corn sap beetle, *Carpophilus dimidiatus* (F.); the dried-fruit beetle, *Carpophilus hemipterus* (L.); *Urophorus humeralis* (F.), and *Haptoncus luteolus* (Er.). There are no common names for the last two species. The corn sap beetle is brown, sometimes with lighter brown areas on the wing covers. The dried-fruit beetle is black with buff-colored spots on the wing covers. *Urophorus humeralis*, the largest of the group, is black. *Haptoncus luteolus* is brown, rather square in outline, and is the smallest. All these beetles feed and breed in fruit and truck-crop waste in the Coachella Valley in California, so that date gardens are exposed to infestation from both inside and outside sources. However, if means can be devised to clean up the permanent infestation in the gardens and to protect the fruit from attack, the damage will be greatly reduced.

In addition to the beetles, the striped larvae of the raisin moth, *Ephestia figulilella* Greg., and the yellowish-white larvae of the Indian-meal moth, *Plodia interpunctella* (Hbn.), infest dates in the gardens. Heavy infestations of both species have been observed when pickings were unduly delayed, but they are not important field pests, and frequent picking followed by prompt fumigation has kept them in hand.

Seasonal Activity of the Beetles

The observations on seasonal activity of the beetles showed a continuous harvest-to-harvest infestation within the gardens. Larvae as well as adults were found to feed on waste dates from November through May. This waste fruit provided a constant source of mature larvae, which entered the soil, transformed, and emerged throughout the winter and spring. February appeared to be the month in which development was slowest. Although larvae continued to enter the soil in February, fewer of them changed to pupae than in months when the soil was warmer. Examination of soil samples indicated that, between November and April, 50 to 65 percent of the immature forms in the soil were pupae, except in February when the percentage dropped to 5 or 10. In May the percentage of pupae increased as the food supply and number of maturing larvae decreased. On July 1 neither larvae nor pupae were found in soil samples taken to include old waste fruit.

Infestation of the new-crop June drops, at least in the Deglet Noor variety, began about the time that the waste of the old-crop dates became useless as food for beetle larvae. This type of infestation was first observed on June 30, when eggs, larvae, and adults were found on dates on the palms and on the ground. The tender skins of the nearly full-sized dates had ruptured, decay had begun, adults were laying eggs in the decaying flesh, and both larvae and adults were feeding on the fruit. The insects continued to attack the new-crop fruit throughout the rest of the season.

Use of Benzene Hexachloride to Kill Larvae Entering Soil for Pupation

Tests with benzene hexachloride, one of the new insecticides which has appeared since the war, showed that it kills larvae and adults quickly. Of the five known isomers of benzene hexachloride, the gamma is the only one that is appreciably toxic to most insects. Methods for using the material had to be devised, and it was found that larvae were killed if they passed through a thin layer of the insecticide as they entered the soil for pupation.

During the fall of 1946 test plots, each 18 feet square with a date palm in the center, were treated with benzene hexachloride dusts containing 0.575 percent of the gamma isomer. Three plots were treated at the rate of 1.8 pounds of gamma isomer per acre and two at the rate of 1.2 pounds. The dust was raked into the soil after it had been spread evenly on the surface. In the plots treated with the heavier dosage 6, 12, and 29 percent as many living individuals were found 7 weeks after treatment as were found in untreated plots. In the plots that received the lighter dosage the percentages were 14 and 35. The better results with a given dosage were obtained in shaded soil and the poorer results in more sandy soil which was only partly protected from the sun. At the end of 11 weeks the insecticide had lost its effectiveness, and the infestation had begun to increase in the treated plots. To be successful the method probably will require more than one treatment each season.

Dusts which contained mixed isomers of benzene hexachloride were used in the series of treatments applied to the fruit in the date-spoilage experiments carried on in collaboration with Donald E. Bliss, of the University of California Citrus Experiment Station. The mixed isomers imparted a decidedly unpleas-

(1) Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture.
(2) University of California, Citrus Experiment Station.

ant odor and flavor to the treated dates.

Use of Irrigation Water to Kill Larvae and Pupae in the Soil

The use of irrigation water to kill larvae was suggested by several growers during the past year. Field observations in the winter of 1945 to 1946, and laboratory work with dried-fruit beetle larvae several years ago, indicated that the idea was feasible. The ground around 12 trees was flooded for periods of 3 to 8 days in January 1947. Soil samples from each tree and an untreated control were examined before flooding and again 26 days afterwards. With one exception, fewer larvae were found after the flooding than before. The exeeption occurred where waste fruit had dropped on the sample point after the flooding. No pupae and practically no larvae were found under trees in soil that had been flooded for 6 or more days, but in soil under the untreated control tree the infestation had increased by 85 percent. Although flooding may not be feasible in gardens on the lighter sandy soils, it seems to offer a means for reducing beetle infestation in gardens on heavier soils.

THE USE OF THIOMATE "19" ON DATES, AND ITS EFFECT ON FRUIT SPOILAGE[1]

Donald E. Bliss and David L. Lindgren[2]
University of California Citrus Experiment Station, Riverside

In 1946 Bliss reported (1) that a mixture of Fermate and sulfur had fungicidal and acaricidal properties when applied to immature dates, and also that relatively few beetles (*Carpophilus* spp.) were found in date bunches where fungus spoilage had been nearly eliminated. A series of preliminary experiments had been conducted to find an effective fungicide that could be removed easily from ripened date fruits, and that would be nontoxic to man when consumed in small quantities. Treatment with the Fermate-sulfur mixture was thought to be sufficiently promising to justify further investigation on a broad experimental basis. A mixture[3] was consequently manufactured and sold by the United Date Growers Association of California, Coachella, California, under the trade name of "Thiomate '19' ". A chemically similar product is manufactured and sold by the Sherwin-Williams Company, Oakland, California, under the trade name of "Date Dust." These products were used in 1946 by a comparatively large number of date growers, both in California and in Arizona.

The writers have treated dates of four varieties with Thiomate "19" in a series of ten controlled test plots. It is the purpose of the present paper to report the results of these tests and to discuss the chemical treatment of dates against those types of fruit spoilage that are caused by micro-organisms, mites, and insects. New information on the removal of the residue of Thiomate "19" from treated dates is also reported.

(1) Paper No. 572, University of California Citrus Experiment Station, Riverside, California.

(2) The writers wish to express their appreciation to Dwight F. Barnes of the U. S. Department of Agriculture, and to Francis A. Gunther of the University of California Citrus Experiment Station, for technical advice; to Robert J. Drake, Lloyd E. Vincent, Paul D. Gerhardt, and George H. Leach, of the University of California Citrus Experiment Station, for assistance; to E. E. McIntyre, The Palm Village Company, the U. S. Date Garden, James Eosley, the Hagberg Brothers, A. E. Callins, and R. S. Dillmon, for supplying plant materials; and to the United Date Growers Association for supplying dusting materials.

(3) Active ingredients (ferric dimethyl dithiocarbamate, 3.41 per cent; sulfur, 92.00 per cent), 95.41 per cent; inactive ingredients, 4.59 per cent.

Materials and Methods

Ten test plots, which were distributed rather widely in the date-growing region of southern California, and four varieties of dates were included in these experiments. Eight of the plots were situated in the Coachella Valley, and two, in the Colorado River Valley, near Bard. Deglet Noor plots were situated near Cathedral City and Oasis; Khadrawy plots, near Indio, Mecca, and Bard; Saidy plots, near Palm Village, Mecca, and Bard; and Medjhool plots, near Indio and Mecca.

Most of the test plots included sixteen fruit bunches: four bunches on each of four palms. The Medjhool plot at Mecca, however, included only eight fruit bunches: four on each of two palms. The bunches were situated, as nearly as possible, on the north, east, south, and west sides, respectively, of the palms. The experimental bunches on one of the palms in the Medjhool plot at Mecca, and on two of the palms in each of the other plots, were left as untreated controls; bunches on the remaining palms were treated with Thiomate "19". Comparatively heavy applications of this dust were first applied to all plots on July 18 or 19, 1946. The dates near Bard received no further treatment, but those in the Coachella Valley were dusted again on July 31, and some were given another light dusting on August 29 after the bagging operation had been completed. The intention was to keep the treated bunches as thoroughly covered with dust as possible throughout the ripening season.

The palms selected for experimental purposes were of such height that the fruit could be treated and picked from the ground or from a short ladder. A Root hand duster was used to apply Thiomate "19" as a blast of dust thoroughly penetrating the fruit bunch and leaving a gray residue on all fruit surfaces. Sulfur dust had been applied previously against date mites in the following test plots: Deglet Noor at Oasis, Khadrawy at Mecca, Saidy at Palm Village and Mecca, and Medjhool at Indio and Mecca.

Fruit bunches were covered in all experimental plots during the latter part of the ripening period. The materials and methods used were not uniform, however, because of the different types of fruit-bunch management employed in different localities and on different varieties of dates. Deglet Noor and Saidy fruit bunches were covered with tubes of heavy, tan-colored ripplecraft paper, the upper edges of which were gathered and tied about the fruitstalks. Saidy dates at Bard were protected by specially designed two-piece paper covers (known to the industry as the Collins and Dillman covers), and the fruitstrands were separated for aeration by inserting 10-inch wire rings. The bunches of Khadrawy dates at Indio and Mecca were enclosed in muslin or cheesecloth, while those at Bard were tied in clean, used flour sacks, and had 8-inch wire rings inserted between the fruitstrands. The Medjhool bunches were wrapped in white muslin of a heavier grade than that used on Khadrawy.

The dates were picked into cloth trays at 14-day intervals, as they ripened, and were transferred immediately to unused paper bags, which were then tied carefully to prevent the escape of insects. The samples were taken to the laboratory, where they were subjected to methyl bromide fumigation, weighed, rated for quality, and examined for fungus and insect spoilage. Fifty dates taken at random from each sample were cut open and examined carefully for evidence of insect infestation. The remaining dates, which usually constituted a large proportion of the total sample, were examined individually for evidence of fungus spoilage. A count was also made of all the adult beetles (family Nitidulidae) in the sample but not within the fruit. These were called "loose" beetles.

Fruit quality was rated from 0 to 10, with perfect fruit taken as 10. Insect infestation was rated on the percentages of fruits containing, within the seed cavity or beneath the skin, the adults, larvae, or excreta of beetles of the family Nitidulidae, and of moths of the family Pyralidae. Evidence of other insects was also noted. No attempt was made to segregate the many different types of fungus and bacterial spoilage, but all infected fruits were determined by sensory tests and separated into one group. The percentages of fungus spoilage were calculated on the basis of weight. Sound fruits remaining after all tests had been made were dry-

cleaned in cloth toweling and distributed for domestic use.

Environmental Factors

Date-fruit spoilage is a complex of several diseases (table 1), some (group 1) caused by unfavorable environmental conditions, others (group 2) caused primarily by living organisms, but also intimately affected by environmental factors such as temperature and moisture. It is with the second group that we are dealing in this report.

The test plots of the 1946 experiments were widely separated so that Thiomate "19" might be tested under as many different environmental conditions as possible. Dates in the Indio district mature relatively early; those in the Cathedral City district, relatively late. These differences in location, together with the inclusion of two early-maturing varieties (Khadrawy and Medjhool) and two late-maturing varieties (Deglet Noor and Saidy), made it possible to observe fruit-ripening over a period of five months.

Table 1. — Diseases of the Date-Fruit-Spoilage Complex.

TYPE OF DISEASE	CAUSE
Group 1:	
Checking, tearing	Water injury
Blacknose	Oxidation of tannins
Shrivel	Moisture deficit, inadequate carbohydrates
Sunburn	High temperature
Mechanical Injury	Wind, etc.
Group 2:	
Side spot	Alternaria spp. and others
Calyx-end rot	Aspergillus spp., Penicillium spp., and others
Fermentation, souring	Yeasts, bacteria
Insect infestation	Carpophilus spp., Ephestia sp., Plodia sp., and others
Surface injury	Mites, birds, mice, etc.

Table 2. — Rainfall Recorded at Palm Springs, Indio, Mecca, and Blythe, California, and at Yuma, Arizona, July, 1946, to January, 1947, Inclusive.*

Date	RAINFALL, IN INCHES, AT				
	Palm Springs	Indio	Mecca	Blythe	Yuma
1946:					
July 11	....	....	....	Trace	....
18	....	....	....	0.41	....
19	....	Trace	....	....	....
21	....	....	....	0.40	....
22	....	....	....	....	0.38
23	....	0.01	Trace	0.47	....
24	....	....	Trace	....	....
25	....	Trace	Trace	....	....
28	....	Trace	....	0.01	0.06
Aug. 11	Trace	....	....	0.01	0.19
18	....	....	0.03	....	....
19	....	Trace	....	....	....
20	....	Trace	....	0.02	....
Sept. 17	....	....	Trace	....	....
18	....	....	....	0.04	0.16
19	....	....	....	Trace	....
26	....	....	....	0.03	....
28	....	....	....	0.06	....
29	....	0.15	0.04	....	0.39
30	0.50	0.20	....	0.15	....
Oct. 1	Trace	....	0.01	Trace	....
27	0.03	0.01	....	0.01	....
28	....	Trace	....	0.03	....
Nov. 9	....	....	....	Trace	....
11	Trace	....	....	....	....
12	....	0.02	0.01	....	....
13	0.80	0.17	0.18	0.20	0.03
14	0.50	0.17	0.20	0.03	0.03
20	....	Trace	....	....	....
23	0.22	0.06	0.01	0.03	0.06
24	0.02	....	....	....	....
Dec. 6	....	Trace	....	0.01	....
23	0.05	....	Trace	....	....
24	0.08	0.75	0.07	....	....
25	Trace	0.03	0.10	0.41	0.25
26	0.05	0.14	....	0.24	0.63
27	0.45	0.02	0.01	0.05	Trace
28	....	....	....	Trace	....
1947:					
Jan. 28	....	Trace	....	....	....
29	0.17	....	....	....	....

* Climatalagical Data, California Sectian, U. S. Weather Bureau, Vals. 50-51, 1946 and 1947.

Rainfall during the period July, 1946, to January, 1947, inclusive (table 2), was about normal for the localities of the test plots. There was only a little precipitation from Indio to Oasis during August, September, and October, when most of the dates in that region were passing through the critical khalal and rutab stages of maturation (4). Weather records from Bard are not available, but the records from two other stations in the Colorado River Valley (Blythe, California, and Yuma, Arizona) indicate that Bard may have had several periods of high relative humidity and light rain during that period. Precipitation at Cathedral City and Palm Village was probably intermediate between that at Palm Springs and at Indio. Because of the very late ripening period for dates in those districts, the experimental fruit was subjected to a number of rainstorms in late fall and winter that did not affect the earlier-maturing fruit in other districts. Furthermore, the Deglet Noor plot near Cathedral City was in an orchard interplanted with large citrus trees, and the high relative humidity and poor aeration in this location were conducive to severe losses from spoilage.

Being located in young orchards, most of the experimental fruit bunches hung within 3 to 6 feet of the ground. The Deglet Noor fruit at Oasis, and the Saidy fruit at Mecca, however, were only 6 inches to 3 feet above the ground. The dates in one of the covered, low-hanging bunches at Cathedral City were observed at 11:00 A.M., September 26, to be covered with many droplets of moisture. Circumstances indicated that the water of transpiration from the dates and from the Bermuda grass below had been retained by the waxy paper cover and had condensed on the fruit surfaces. These dates developed much checking, blacknose, shrivel, and fungus infection.

The sunburning of fruitstalks and fruitstrands was observed principally on the southern and western sides of palms in the Khadrawy plot at Indio and in the Deglet Noor plot at Oasis. Burning occurred about equally on treated and untreated bunches.

Results

Treatment with Thiomate "19" seemed to improve the quality of dates in seven of the ten test plots (table 3). The higher mean ratings of treated fruit in these plots were based on the reduction in fungus and insect spoilage resulting from the treatment. Little or no difference was apparent in other characters such as size, color, shape, flavor, or texture of the fruit. Untreated dates were given higher quality ratings than treated dates in two plots (Deglet Noor at Oasis, and Medjhool at Mecca) because less fruit-shriveling occurred in the untreated fruit. Although the treatment may have increased fruit-shriveling, it was considered likely that extraneous factors had been mostly responsible.

Fungus Spoilage. The percentage of fungus spoilage was reduced in all test plots by the treatment with Thiomate "19" (table 3). Significant differences, as measured by the "t" test (3), were obtained from the four test plots where fungus spoilage had been most severe. In the Deglet Noor test plot at Cathedral City, 79.15 per cent of the untreated and 50.35 per cent of the treated dates were spoiled by fungi. The treatment, although not so effective as might be desired, was responsible for saving about one third of the crop. In the Saidy test plots, the results were even more encouraging, since the losses caused by fungi were only approximately one third as great in the treated fruit as in the untreated. Fungus spoilage in the test plot at Bard, for instance, was reduced from 45.84 to 18.48 per cent, a highly significant difference.

Table 3. — Effect of Treatment with Thiomate "19" on Fruit Quality, Fungus Spoilage, and Infestation by Beetles* and Raisin Moths† in Four Varieties of Dates of the Crop of 1946.

Plot Location and Treatment	Total Amount of Fruit (kg.)	Fruit-Quality Rating (10=perfect)	Fungus Spoilage (per cent)	Beetles*		Raisin Moth† Fruit Infestation (per cent)
				Number per Kilogram of Fruit	Fruit Infestation (per cent)	
Deglet Noor						
Cathedral City:						
None (control)	68.1	1.27	79.15	62.5	11.77	0.08
Thiomote "19"	79.6	3.29	50.35‡	34.1‡	8.03	0.00
Oasis:						
None (control)	64.7	5.88	4.96	33.5	9.22	4.57
Thiomote "19"	48.3	4.42	2.25	4.8	2.02§	0.07§
Khadrawy						
Indio:						
None (control)	67.8	5.49	5.75	29.3	6.31	1.75
Thiomote "19"	52.0	6.58	1.32	0.8	1.05‡	0.12‡
Mecca:						
None (control)	65.5	6.03	3.58	35.5	4.52	0.22
Thiomote "19"	63.9	6.75	1.05	7.7‡	0.66‡	0.00
Bard:						
None (control)	37.6	6.00	3.22	4.5	3.57	0.61
Thiomote "19"	26.4	6.00	2.76	0.2‡	0.29§	0.00‡
Saidy						
Palm Village:						
None (control)	79.1	6.05	22.74	2.4	2.68	0.29
Thiomote "19"	84.0	6.36	8.65§	0.0	0.05	0.00
Mecca:						
None (control)	62.8	6.00	9.36	11.2	5.06	0.00
Thiomote "19"	47.8	6.50	3.21§	0.9	0.70§	0.00
Bard:						
None (control)	30.4	4.19	45.84	4.4	13.87	0.25
Thiomote "19"	24.4	5.53	18.48§	2.3	0.83§	1.67
Medjhool						
Indio:						
None (control)	94.2	5.40	3.88	8.6	4.62	8.15
Thiomote "19"	95.7	6.06	3.24	4.1	1.69§	9.96
Mecca:						
None (control)	48.6	6.87	4.82	15.6	6.05	2.62
Thiomote "19"	36.7	6.13	1.24	0.6	0.57‡	0.00

* Corpophilus hemipterus (L.), C. dimidiotus (Fob.), Urophorus humerolis (Fob.), and Hoptoncus luteolus (Er.), all of the order Coleoptero, family Nitidulidae.

† Ephestio figulilello Greg., order Lepidoptero, family Pyrolidae.

‡ Significant at the 5 per cent level, as shown by the "t" test (3).

§ Significant at the 1 per cent level.

The types of fungus spoilage observed in the 1946-47 crop varied considerably according to the variety of dates and the period of ripening. Calyx-end rot, caused by *Aspergillus niger* V. Tiegh., was of principal importance in the Deglet Noor variety. Early-maturing dates in the region from Indio to Oasis were essentially free from side-spot lesions, but the late-maturing dates near Cathedral City were rather generally affected. These side spots were caused by such fungi as *Alternaria citri* E. and P. em. Bliss and Fawcett, *Pleospora herbarum* (Pers. ex Fr.) Rabenh., and *Cladosporium herbarum* Link.

Fermentation and souring were of principal importance in the spoilage of Khadrawy dates. These closely related diseases were presumably caused by various species of yeasts and bacteria (2), and they were detected mostly by smelling and tasting the fruit. Colonies of *Cladosporium herbarum* were noted occasionally under the calyx in fruit from Mecca, but symptoms of calyx-end rot and side spots were practically nonexistent.

A general darkening or blackening of the flesh associated with a green species of *Penicillium* was most common in Saidy fruit. The retention of the calyx on picked fruit was often indicative of this trouble. Dark-colored side spots were also found on fruit in the plots at Palm Village and Bard.

The Medjhool dates were slightly affected with both calyx-end rot (*Aspergillus niger*) and souring. Certain unidentified, slow-growing molds were also found about or beneath the calyx of fruit in the Indio plot.

Insect Spoilage. In addition to fungi, there were four species of beetles of the family Nitidulidae that were principally associated with date-fruit spoilage in 1946. Of these, the two most commonly observed were *Carpophilus hemipterus* (L.) and *C. dimidiatus* (Fab.); *Urophorus humeralis* (Fab.) was observed occasionally, and *Haptoncus luteolus* (Er.) rarely. Insects of these species, which will be referred to hereafter as "beetles," showed a remarkable response to the treatment with Thiomate "19" (table 3). The number of loose adult beetles per kilogram of fruit, and the percentage of infested dates, were both reduced by the treatment in all test plots. The differences in the number of loose beetles in untreated and treated fruit samples were statistically significant in three out of ten plots, and differences in fruit infestation were significant in eight.

In several instances the differences in beetle population were so marked that they were evident even to a casual observer.

Two species of moths of the family Pyralidae formed a second major group of insects causing date-fruit spoilage in certain orchards. Injury caused by the raisin moth, *Ephestia figulilella* Greg., was of economic importance, while that caused by the Indian-meal moth, *Plodia interpunctella* (Hbn.), was not. Fruit infestation by the raisin moth reached serious proportions in the Deglet Noor plot at Oasis, and in the Medjhool plots at Indio and Mecca (table 3). Although the treatment with Thiomate "19" reduced the percentage of infestation by larvae of the raisin moth in seven of the ten test plots, there were two plots in which the treated dates had a higher percentage of infestation than the controls. Since this was true at Indio, where untreated Medjhool dates showed 8.15 per cent infestation by *Ephestia*, the effectiveness of the treatment against this insect seemed doubtful. The populations of Indian-meal moths in all plots were so small that no opinion could be formed regarding their response to Thiomate "19".

The date mite, *Paratetranychus simplex* (Banks), was found on some bunches of the Deglet Noor variety at Cathedral City and at Oasis. These infestations disappeared, however, after the bunches had been treated with Thiomate "19".

Fruit Cleaning. The problem of removing the residue of Thiomate "19" from ripened dates has been a cause of concern to the operators of the date packing houses. Various types of cleaning machinery have been introduced which appear to offer considerable advantage over the method of cleaning dates on a shaker table lined with Turkish toweling.

Three lots of Deglet Noor dates were picked October 2, 1946, from one of the experimental plots near Indio. The first lot had been treated previously with sulfur dust, the second with Thiomate "19" (5 per cent Fermate[4] in sulfur dust), and the third with Thiomate "9" (10 per cent Fermate in sulfur dust). Each lot was then divided into three samples treated as follows: the first, not cleaned; the second, cleaned with dry rotating brushes in packing-house A; and the third, cleaned with moist rotating brushes in packing-house B. The nine samples were then analyzed for ferric dimethyl dithiocarbamate,[5] the active ingredient in Fermate. The residue of ferric dimethyl dithiocarbamate, as indicated by these analyses (table 4), was removed more effectively by the moist brushes than by the dry ones. Although these results are not entirely comparable with those reported in 1946 on Deglet Noor fruit cleaned by rubbing with a dry cloth (1), it is reasonably certain that both the dry-brush and the moist-brush cleaning methods are preferable to the dry-cloth method.

(4) See footnate table 4.

Table 4. — Relative Efficiency of Different Cleaning Methods for Removal of Residue of Ferric Dimethyl Dithiocarbamate from Date Fruits.

Fruit Treatment	Residue of Ferric Dimethyl Dithiacarbamate on Fruits (p.p.m.)*		
	Nat Cleaned	Cleaned With Dry Rotating Brushes	Cleaned With Moist Ratating Brushes
Sulfur dust	0.424	0.171	0.000
Thiomate "19" (5 per cent Fermate† in sulfur dust)	5.100	4.368	1.987
Thiomate "9" (10 per cent Fermate in sulfur dust)	15.330	11.292	6.915

* Fresh-weight basis; dates with seeds.

† Product of E. I. du Pont de Nemours and Co. (Inc.), containing 70 per cent ferric dimethyl dithiocarbamate.

A cleaning test was made by Mr. Leonhardt Swingle, of Indio, California, in April, 1946, on some flats of Deglet Noor dates of the 1945 crop that had not been previously cleaned or sorted. The fruit in one flat was left undusted; that in the other flats was dusted thoroughly with Thiomate "19". Leaving some of the dusted fruit uncleaned, he divided the remainder into two parts, passing one part over moist towels on a shaker table, and the other part over a newly designed cleaning machine having moist rotating brushes. This machine was later installed in packing-house B. Samples of the four lots were submitted to the Bureau of Chemistry of the California State Department of Agriculture for chemical analyses. In a letter to one of the writers, under the date of April 23, 1946, Mr. Allen B. Lemmon, Chief of the Bureau, reported his findings as follows:

(5) Analyses mode according ta the methad of J. B. LaClair, af the Bureau af Chemistry, California State Department of Agriculture, as outlined in personal carrespondence ta the writers, Sept. 2, 1946.

Sample No. and Dust Treatment	Cleaning Method Used	Residue of: Ferric Dimethyl Dithio-carbamate (p.p.m.)	Residue of: Sulfur (p.p.m.)
1. Thiamate "19"	None	16.62	185.61
2. Thiamate "19"	Moist towels an shaker table	5.61	19.11
3. Thiamate "19"	Moist ratating brushes	4.90	11.82
4. None	None	—*	6.41

* Dash indicates negative results.

Tests were also made on three lots of field-run Deglet Noor dates, all of which had been treated with Thiomate "19" by the growers. These lots of dates were collected in October, 1946, while in the process of being cleaned in two packing houses where machines with moist rotating brushes had been installed. The residues of ferric dimethyl dithiocarbamate in these lots, before and after cleaning, were found to be as follows:

Lot No.	Packing Hause	Residue af Ferric Dimethyl Dithiocarbamate: Before Cleaning (p.p.m.)	Residue af Ferric Dimethyl Dithiocarbamate: After Cleaning (p.p.m.)
1	B	17.50	5.95
2	C	1.40	0.70
3	C	1.75	1.05

The various chemical analyses mentioned above indicate a rather wide variation in the deposit of Thiomate "19" on Deglet Noor fruit. No data on dust residues on dates of other varieties, either before or after cleaning, are available.

Discussion

Date-fruit spoilage is a very complex problem because there are so many factors involved. Differences in the response of date varieties, a wide range of environmental conditions, and a large number of disease agents, all contribute to an intricate situation. The problem has been attacked from different angles by many investigators, and, as a result, new or improved methods of fruit-bunch management have been developed, each reducing spoilage losses to some extent.

Treatment with Thiomate "19" appears to be another step in the same direction. With this treatment, significant reductions have been effected, both in fungus spoilage and in insect infestation, without lowering the quality of the fruit. The nitidulid beetles are not killed, but seem to find treated dates less attractive than untreated ones. Although not understood, two possibilities are suggested to account for this response: (1) that Thiomate "19" acts as a feeding inhibitor; and (2) that the nitidulid beetles, being scavengers and attracted principally to decomposing plant materials, are not found commonly in dates where fungus spoilage has been nearly eliminated.

Thiomate "19" may be used as an acaricide for controlling the date mite, but it is not preferred to sulfur. The reason is merely one of cost, since Thiomate "19" is about twice as expensive as sulfur. For the control of date mites, we suggest, therefore, one treatment of 325-mesh dusting sulfur applied early in June.

Thiomate "19" is suggested for application on a broad experimental basis on date fruit as a PREVENTIVE measure against infection by molds and yeasts (fungi), and against infestation by nitidulid beetles. Its effect on raisin moths and Indian-meal moths is questionable. Dates, excepting "June drops," do not become susceptible to spoilage from fungi and beetles until the end of the kimri (green) stage of maturity, when they have reached maximum size. Two applications of Thiomate "19" will usually suffice. The object is to maintain a thorough coverage of dust on all fruit surfaces during the period from midsummer, when the dates are nearly full size, until fruit maturity. Dust treatment following the installation of fruit protectors (bags) tends to give a thorough coverage of all fruit surfaces if a blast of dust can be directed into each bunch from below.

The problem of obtaining the minimum effective dosage of Thiomate "19" has not been solved. In the past our experimental fruit bunches have probably received an overdose, while dates in some of the commercial orchards have probably not received enough. Low-hanging fruit bunches may be effectively treated with a knapsack duster, using 10 to 12 pounds of the dust per acre for one application. For dusting the fruit bunches on tall palms, a power duster equipped with one or more long, manually operated delivery tubes is needed. About 20 pounds of dust are required per acre for one application with this equipment. Date dusting, unlike many other dusting operations, is a type of spot treatment intended principally for the fruit surfaces. No harm results from dusting the leaves and trunk of the palm, but such application has only minor value. Thiomate "19" has excellent dusting properties, but like sulfur, it will irritate the eyes, and, with some people, cause an allergic reaction when it is rubbed into scratches on the skin.

As to the possible health hazard to the consuming public, no direct toxicological evidence is available regarding the residue of Thiomate "19" on dates. There is much indirect evidence, however, that it is essentially nonpoisonous.

The operators of the packing houses are to be commended on their efforts to remove the residues of these dusts. The problem of cleaning dates is not entirely solved, especially the cleaning of fruit of Khadrawy and other soft varieties, but considerable promise is seen in the newly designed machines equipped with moist rotating brushes. There is a growing conviction that the method of cleaning dates on a shaker table lined with Turkish toweling is not adequate to remove dust residues. The present trend toward improved and more sanitary methods of cleaning is therefore of great importance.

Fruit spoilage is considered to be the most serious hazard in date production. Although it has been reduced considerably by treatment with Thiomate "19" and by various other means, it will probably never be entirely eliminated. To the consumer, the superiority of American-grown dates depends not only on quality and uniformity, but also on freedom from spoilage, a condition which, within small working tolerances, is required by the newly revised Agricultural Code of California. For these reasons it behooves the local growers, packers, and handlers of dates to employ all effective and practicable means of controlling fruit spoilage.

Summary

Deglet Noor, Khadrawy, Saidy, and Medjhool dates in ten controlled test plots were treated during July and August, 1946, with Thiomate "19," a mixture of 5 per cent Fermate in sulfur. The data obtained later from examination of the ripened fruit warranted the following generalizations:

1. Fruit quality, except as to fungus and insect spoilage, was usually not affected by the treatment.

2. Fungus spoilage was always reduced, the differences being statistically significant in four plots.

3. The number of loose nitidulid beetles per kilogram of fruit, and the percentage of infested dates, were reduced by the treatment in all test plots. The values for loose beetles were statistically significant in three plots, and those for fruit infestation were significant in eight.

4. The response of the raisin moth, *Ephestia figulilella* Greg., to the treatment was doubtful, and the populations of the Indian-meal moth, *Plodia interpunctella* (Hbn.), were so small that no opinion could be formed.

5. Infestations of the date mite, *Paratetranychus simplex* (Banks), disappeared after infested bunches were treated.

Of three methods of date-fruit cleaning tested, that with moist rotating brushes was most effective, and that with Turkish toweling on a shaker table was least effective.

Thiomate "19" is suggested for application on a broad experimental basis on date fruit as a PREVENTIVE measure against infection by fungi, and against infestation by nitidulid beetles. It may also be used as an acaricide for controlling the date mite, but for this it is not preferred to sulfur.

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PROGRESS REPORT ON THE OMPHALIA DATE ROOT ROT SURVEY

By Glenn KenKnight and Raymond O. Amling[1]

The Omphalia Date Root Rot Survey of the State Department of Agriculture began in October, 1945. A year ago it was reported that Omphalia had been isolated from 12 percent of all date root samples, and from one or more palms in two-thirds of the orchards where more than ten root samples had been taken (10)[2]. This picture has not changed.

Background

A disorder that became known as date decline was first noted as affecting a single palm in Garden G[3] (11,12). When scientific studies began in 1927, decline was noted in four plantings of Deglet Noor palms. Although early investigators considered several possibilities relative to the cause of the disorder, they thought that the trouble most probably was in some way related to the soil (8,9,13), and they observed that spread within an orchard appeared to reach definite limits (9). Soil amendments with both major and minor elements were tested (7, 9). However, a planting experiment in Garden V appeared to indicate that the disease is spread on offshoots[4] and circumstantial evidence was presented to substantiate this (5, 7). Replanting experiments in decline areas appeared to indicate that the trouble is soil-borne (2, 7). Soil treatment experiments in Gardens C and V were regarded as furnishing evidence that soil-infestation can be eliminated by disinfection with carbon bisulfide (2, 7)[5]. Offshoots from declined palms usually began normal growth and continued to appear normal for about five years, after which the growth rate decreased and the palms became weak (7). During this latent period, infected offshoots might be inadvertently removed for further propagation. It was observed that two species of Omphalia (*O. tralucida* and *O. pigmentata*) are associated with decline (3), and it was demonstrated that these fungi are capable of damping-off and rotting the roots of potted date seedlings, and of rotting the roots of date seedlings and a young date palm out of doors (7)[6]. Furthermore, Omphalia-infection was demonstrated to have preceded decline on two palms in Garden N[7]. In view of this, *Omphalia* spp. were considered to be the causal organisms of date decline, and the name Omphalia root rot was suggested for the disease. Because other factors may cause a weakened condition in palms, and because of the long time between infection and onset of symptoms, the isolation of Omphalia has been considered to be the most reliable means of diagnosing the disease. Omphalia root rot was regarded as the most serious disease of date palms in the Coachella Valley, and to be a potential threat to date production there. It was estimated that about one percent of the Deglet Noor palms were affected by the disease. Prevention of the introduction of Omphalia into other orchards by means of a quarantine was recommended (5) and put into practice (15).

Procedure Followed and Difficulties Encountered

The main purpose of the survey is to locate sources of disease-free offshoots for propagation. This means dealing with young orchards where decline symptoms may not have yet appeared. Consequently, it seemed desirable to learn the source of the palms when this information was available.

Charting Orchards

In view of the possibility of confusing symptoms of the disease attributed to Omphalia with symptoms arising from other causes, the agricultural inspectors were instructed to grade all palms as apparently healthy, weak, or very weak, using the symbols dot (•), line (/), and cross (×), respectively. This grading is based on the general appearance of the palm. Vigorous palms tend to carry more green leaves than weak ones, but young palms generally carry more green leaves than older palms, so that no absolute number of leaves can be employed in grading. The number of fruit bunches means little, because many palms tend to be alternate in bearing, but the diameter of the fruit-stalks seems important. The vigor of current season growth is affected by the fruit load and the number and size of offshoots, and, then, it is not easily measured on tall palms. The color is important,—weak palms tend to have yellowish leaves and midribs.

The inspectors have varied considerably in their grading of palms, some emphasizing one criterion and some another. Furthermore, they tend to set their sights according to the orchard they are in, so that few orchard maps, no matter how excellent the orchard, are totally free from palms that have been graded as weak. This is mentioned in order to point out that statistics based on the number of weak palms are open to criticism. However, extremely weak palms are given a cross by any inspector.

The number of palms graded as weak greatly exceeds the number that were suspected of having Omphalia root rot. It is difficult to decide which ones of them should be regarded as diseased. Plants of all crops often vary widely in vigor within a plantation even in the absence of any obvious disease. Furthermore, in irrigated regions where land has been levelled, areas where the surface soil has been removed to a considerable extent are commonly comparatively barren. In these areas where flood waters deposited silt between sand dunes, the irregularity in water-holding capacity and fertility of the levelled land might be expected to be rather extreme.

With normal care, a healthy Deglet Noor date palm grows 12 to 30 inches a year, spacing its leaf whorls 10 to 18 inches apart. The distance between whorls and between leaves in a whorl, the width of leaf bases, and the diameter of leaf midribs, fruit stalks, and the trunk of the palm are all correlated with vigor of growth. Inasmuch as a date palm generally retains its old leaf bases for a decade or two or longer, it is possible to determine the growth history of a palm by examining the leaf bases. As a palm declines, the distance between whorls lessens to six or even two inches, and, in extreme cases, may approach zero or even appear to be a minus quantity. Under these conditions, the leaf bases appear to pile up, one behind

1. Associate Plant Pathologist and Junior Plant Pathologist, respectively, of the State Department of Agriculture.

2. Numbers in brackets refer to literature cited.

3. Orchards where Omphalia was found prior to the survey have alphabetic designations (7).

4. This is based on a single experiment without replication.

5. Irrespective of experimental treatments, the present condition of the palms in this portion of Garden C appears to be closely related to moisture supply. See Table V.

6. In the experiment with standard date varieties, root rot developed on one of three inoculated palms and on one of seven controls.

7. These two palms declined one year after discovery of infection, whereas in the same area decline has not set in on any of 10 palms demonstrated to have been Omphalia-positive in 1936.

Table I — Summary of All Root Platings.

	Number of Praperties			Number af Samples		
	Omphalia-Positive	Total	%	Omphalia-Positive	Total	%
Date palms (Phoenix dactylifera)						
Major Variety						
Deglet Noor	32	72	44	128	1098	11
Principal Minor Varieties						
Khodrawy	5	12	42	11	46	21
Zahidi	2	10	20	9	57	16
Saidy	3	5	60	7	42	17
Halawy	2	3	67	3	12	25
Rhars	1	2	50	6	19	32
	9	19	47	36	176	20
Other Minor Varieties						
Barhee	0	1	0	0	1	0
Bent Keballa	0	1	0	0	1	0
Boo Holos	1	1	100	1	1	100
Dubaini	0	1	0	0	1	0
Halaaa	0	1	0	0	1	0
Hayony	0	1	0	0	3	0
Iteema	0	2	0	0	4	0
Maktoom	0	2	0	0	2	0
Medjhool	0	1	0	0	15	0
Korrao	0	1	0	0	1	0
Taborzol	0	1	0	0	1	0
Thoary	0	2	0	0	2	0
Tranja	0	1	0	0	1	0
unidentified	1	4	25	2	6	33
	1	7	14	3	40	8
Cammerciol seedlings	2	8	25	4	69	6
male	5	20	25	9	46	19
all dote polms	39	82	48	180	1429	13
Native palms						
Woshingtania filifera	0	8	0	0	73	0
Ornamental palms						
Phoenix sylvestris	1	1	100	3	3	100
P. conariensis	0	1	0	0	26	0
Butia Bonneti	0	1	0	0	1	0
Sabal Texono	0	1	0	0	2	0
	1	2	50	3	32	9
GRAND TOTAL	40	89	45	183	1534	12

another. In an orchard that has undergone a period of near abandonment followed by good care, each palm has a zone of closely packed leaf bases[8]. If the orchard had been viewed at the time that these were being produced, it would have been most difficult to distinguish the condition from what is known as the decline disease. Palms with decline symptoms retain fewer and fewer leaves, but revival of growth can be noted long before a substantial head of green leaves is regained by the difference in diameter of leaf midribs on new and old leaves. It is evident that in some groups of weak palms, the palms have been stunted from the start, and, at the age of 10 or 15 years may not be as large as normal five year old palms.

Decline areas are said to have enlarged (7), and field observations indicate that this has taken place in some instances. When all of the palms in an orchard block appear to have declined more or less simultaneously, neglect, rather than disease, is suspected. If decline is confined to certain areas within a block, it might be due to soil irregularity. Even if spread of decline symptoms appears to have taken place, it does not necessarily indicate that a transmissible disease is responsible. Where irrigation is inadequate, drought symptoms appear first where water penetration is the poorest or where water-holding capacity of the soil is least, and appear to spread if inadequate irrigation continues. In furrow irrigation, if the soil is fairly uniform, the palms at the head of the flow get the most water, and those at the foot also get more than their share under inadequate irrigation, because the water usually tends to pile up there. Drought symptoms may be expected to make their appearance about two-thirds of the way down the water run and spread toward both ends if inadequate irrigation continues. Also, with nitrogen or other nutritional deficiencies, the palms in the most deficient area would suffer first and the symptoms of deficiency would appear to spread as the element in question is depleted. Furthermore, the possibility of the occurrence of contagious disease other than Omphalia root rot should not be overlooked.

Palms derived from Omphalia-contaminated offshoots are said to usually grow quite normally for about five years, after which time decline symptoms appear. Consequently, in looking for infested areas, evidence that a latent period has occurred is sought. However, such a sequence does not necessarily indicate the presence of a disease-producing organism. Young palms require frequent irrigation, but usually only the row, not all the land, is irrigated. As they get older and their roots penetrate more deeply, more water will be required or decline symptoms will set in. Offshoots are not usually removed from young palms until they are four years old or older. Later, if, in a careless manner, too many offshoots are taken from a palm at one time so that a large proportion of the shallow roots are cut, the palm may appear to decline. This type of damage may be expected to occur most commonly in fairly heavy soils, because Deglet Noor palms apparently produce offshoots more abundantly in such soils than in soils that are sandy at the surface. Perhaps little is known about the minor element requirements of date palms, but it should be pointed out that with some minor element deficiencies, plants may begin apparently normal growth, but deteriorate later (1).

Root Sampling

The number of root samples that may be taken is limited by the number that may be handled in the laboratory. In apparently healthy orchards, every fifth palm (four percent of the palms) is sampled, with slight deviations in the pattern to include the weakest palms (Chart I). These are sampled on the north or east sides or under dead offshoots because of the advantage in finding Omphalia by so sampling, as pointed out in last year's report (10). A hole is dug 8 or 12 inches from a palm to a depth of 18 to 30 inches. Because it is necessary to find some rot in order to isolate Omphalia, the search for rotten roots usually results in somewhat larger excavations beside apparently healthy palms than by weak ones.

Laboratory Technique

All roots apparently wholly free from necrotic tissue are discarded. The roots to be plated are thoroughly washed in flowing tap water, and cut into half-inch segments. Each piece is dipped momentarily in 0.1

8. As growers have pointed out, o zone of closely pocked leaf boses olso morks the disostrous freeze of 1937.

Table II — Relation of number of Samples Taken to Isolation of Omphalia. Date Palms Only.

Number of Samples	Properties Yielding Omphalia from One or More Root Samples: New Properties* Omphalia Positive	New Properties* No. of Properties	New Properties* % Positive	All Properties Omphalia Positive	All Properties No. of Properties	All Properties % Positive
1—5	3	27	11	3	28	11
6—10	5	12	41	6	15	40
11—15	3	8	38	4	9	44
16—20	5	7	71	8	10	80
21—30	3	4	75	7	8	88
31—163	9	10**	90	11	12**	92
all	28	68	41	39	82	48
The same data expressed in a slightly different manner						
More than 1	28	58	48	38	72	53
" " 2	27	51	57	37	64	58
" " 3	26	46	57	36	59	61
" " 5	25	41	61	35	54	65
" " 10	20	29	69	30	39	77
" " 20	12	14	86	18	20	90
" " 30	9	10**	90	11	12**	92

* That is, excluding properties where Omphalia had been found prior to the survey. Fourteen alphabet gardens were sampled of which Omphalia was obtained from 11. However, these include I and O where Omphalia was presumed eradicated, the control block in X, and a presumed healthy block in P os well as an additional block in C.

**Although no Omphalia was obtained from date palms on one property (no. 27), Omphalia was obtained from 3 P. sylvestris palms. However, counting of all root samples from ornomental palms would depress the percentages shown in the table.

Table III — Palm Vigor in Relation to Omphalia.

VARIETY	HEALTHY	WEAK	VERY WEAK
Deglet Noor	67/665*	24/204	31/191
	10%	12%	16%
Khadrawy	11/40	0/2	0/0
	28%		
Zahidi	9/48	0/4	0/5
	19%		
Saidy	3/12	0/0	3/4
	25%		75%
Halawy	3/12	0/0	0/0
	25%		
all	12%	11%	17%

* The numerotor of the fraction is the number of samples yielding Omphalia, and the denominator the total number of samples.

percent mercuric chloride solution and rinsed in a solution containing 10 percent commercial Clorox. Fairly large root segments and brief surface sterilizations seem necessary because of the porous nature of palm roots. Very small root tips are merely dipped in the Clorox solution. Platings are made on potato glucose agar in Petri dishes to which 0.2 c.c. of two percent silver nitrate (kept in a dark glass bottle) and a drop of 85 percent lactic acid have been added at the time of pouring (about 20 c.c. of agar per dish). The silver nitrate inhibits the growth of *Omphalia* spp. far less than that of many palm root and soil-inhabiting fungi.

Roots with dry, light brown rot streaked with white mycelium, as described and pictured in Hilgardia (7), yield Omphalia regularly. However, Omphalia is occasionally obtained from roots that do not have this appearance, and even from necrotic root tips in the absence of dead primary roots in the samples. Weak palms commonly have a considerable percentage of rotten roots, giving more material to plate form than can usually be obtained from apparently healthy palms. However, difficulty has been experienced in some orchards (Garden Q, property nos. 3 and 48)[9] in isolating Omphalia from severely declined palms,—an observation that has also been noted in the literature (7). The consequence is that the correlation between percent of rotten roots in the samples and the isolation of Omphalia closely approaches and is not significantly different from zero, meaning that there appears to be no consistent relationship. The correlation that might be expected may be masked by other fungi superseding Omphalia on rotten roots, or by the occurrence of roots rotted by other causes. The importance of finding rotten roots is illustrated by the report of last year (10) that Omphalia was obtained much more readily from root samples taken from beneath dead offshoots on otherwise normal palms than from other samples taken from apparently normal palms; and that in orchards where decline symptoms are not evident, Omphalia has been isolated from palms that died suddenly from "rhizosis" and even from a palm struck by lightning (4, 7).

Fungi are always found in rotten date roots. Among the more common ones are *Fusarium*, *Rhizopus*, *Rhizoctonia*, *Ceratostomella radicicola*, *Penicilium*, and *Aspergillus*. There is a correlation between the percent of rotten roots and the occurrence of some of these, and with Fusarium the correlation is high. The latter is usually obtained from damp rot. Dead root tips yield Ceratostomella, Rhizoctonia, Omphalia, and other fungi. However, of these, only Omphalia and Ceratostomella have been considered capable of parasitism on palm roots (7)[10].

In light soils *Ceratostomella radicicola* has been isolated from the roots of declined palms with much greater regularity than has *Omphalia* spp. For example, on property no. 3, in a decline area, Omphalia was obtained from only one of 18 root samples, whereas *C. radicicola* was obtained from all 18. *C. radicicola*, like Omphalia, appears to be less easily obtained from rotten roots in heavy soils than in light soils. *C. radicicola*, like Omphalia, is frequently found in the absence of decline symptoms. Although it is conceivable that both may contribute to the decline of neglected palms, there is no field evidence that *C. radicicola* is of economic importance in well-managed orchards.

Identification of Omphalia

Omphalia tralucida and *O. pigmentata* produce sterile, white colonies that are quite similar in appearance. The mycelium has clamp connections, and, in mass, looks a bit like glass wool (7). These characteristics are not sufficiently distinctive to unmistakably identify the fungi. Perhaps the only really absolute identification can be made by producing the mushrooms on the basis of which the fungi were described. Although these have been produced under conditions of high humidity and high temperature (3) they have not been observed in the

9. Properties sampled during the survey are numbered in the order in which the first root sample was taken; Omphalia-infested properties located prior to the survey are designated by letters of the alphabet (7). Omphalia, as used here, refers specifically to O. trolucida and O. pigmentato.

10. Ceratastamella radicicola was described as the causal organism of "rhizosis" or rapid decline of date palms. However, doubt later arose as to its relationship to that disease (4).

course of the survey. The method employed is to determine the pathogenicity of the isolates on date seedlings (7). Because a rather large amount of inoculum must be placed in intimate contact with the below-ground stem of a date seedling in order to unfailingly cause damping-off, the inoculum is prepared on chips of date wood, and a piece of Omphalia-impregnated date wood pressed into the soil snugly against the stem of each seedling. The time required to produce damping-off varies according to the temperature, the amount of inoculum, the age of the seedling, and seemingly also according to the isolate. Usually several seedlings from each inoculation have dampt-off within 10 days.

The method used in identifying these species of Omphalia is one that would not likely be employed by anyone not working on diseases of dates, so that possible isolation of these species by other workers from other plants would probably not be noted in the literature in such a way as to bring it to our attention.

Table IV — Locations of Apparently Healthy Orchards Ten Years Old or Older, Where Omphalia Has Been Found on Deglet Noor.

PROPERTY	LOCATION	APPROXIMATE AGE OF PALMS SAMPLED
53	Garnet	23 years
66	Indian Wells	22 "
24	Indio	21 "
89	"	13 "
62*	Coachella	18 "
49	Thermal	18 "
4	High School	14 "
25	" "	15 "
26	" "	15 "
32	Arabia	12 "
37	"	12 "

* A few declined palms occur here (Garden N), but see text and footnote 7.

DISTRIBUTION OF OMPHALIA IN THE COACHELLA VALLEY

Sources of Offshoots

Much information on sources of offshoots has been obtained from notes at the U.S.D.A. Entomological Field Station at Whittier. These were taken by B. L. Boyden and others, and also contain transcriptions of notes taken by other workers. These notes have been difficult to employ because of the large turnover in property ownerships. In some instances further information has been obtained from growers. However, the information is as yet very incomplete.

In the summary of earlier investigations (7) it was stated that the evidence presented indicates that Omphalia root rot was apparently introduced from north Africa. This evidence together with supplementary evidence is presented in Table VI. In some of the years mentioned, there was more than one importation from Algeria, but these have not been separated. Palms from the 1913-15 importations from Algeria occur in many orchards, but usually not in pure stands. It seems impossible to separate them from the standpoint of estimating the number of palms derived from them. Because *Omphalia* spp. apparently produce no spores under field conditions in the Coachella Valley, and because no evidence has been obtained that Omphalia can spread through the soil in the absence of palm roots, it was reasoned that the source of an initially Omphalia-infected palm is also the source of the organism. With this line of reasoning, Omphalia appears to have been introduced from Algeria in 1903, 1911, 1914, 1915, and 1922; from Iraq in 1913; and from Egypt in 1921. The finding of Omphalia in a commercial orchard planted from seed on virgin soil, and on *Phoenix sylvestris* grown from seed at Washington, D. C., and shipped to Indio in pots may be regarded as circumstantial evidence that Omphalia may be endemic. The possibility exists that Omphalia may spread through the soil to a greater extent than has been suspected, and that in some of the instances mentioned, Omphalia may have been introduced by unrecorded replantings of missing palms with offshoots from other sources. Omphalia has not been found on the native palm, *Washingtonia filifera.*

Summary of the Findings of the Survey

The data includes root samples taken up to May 20, 1947. Omphalia, as used here, refers specifically

to *O. tralucida* and *O. pigmentata*.

1. The use of silver nitrate in the plating medium has increased the percentage of root samples yielding Omphalia.

2. Golden Bantam sweet corn (*Zea mays*) was found to be susceptible to damping-off by both *O. tralucida* and *O. pigmentata* when inoculated in the manner used to demonstrate the pathogenicity of Omphalia on date seedlings.

3. Omphalia has been found on 39 properties out of 82 where date palms were sampled. This includes 11 properties where Omphalia had previously been reported, but on two of these, Omphalia was presumed to have been eradicated, and on three, Omphalia was found in additional orchard blocks. This brings the total number of properties where Omphalia has been found on one or more palms to 64. The accompanying map shows the distribution in the Coachella Valley. Omphalia was also found at Brawley and at Yuma, and had previously been reported from Riverside.

4. The present known distribution of Omphalia involves 14 townships and 37 sections. During the survey it has been found in every township where more than one property was sampled.

5. The finding of Omphalia on a property is closely correlated with the number of root samples taken. It was found in more than two-thirds of the orchards where more than 10 root samples were taken, considering only those where it had not been reported prior to the survey (Table II).

6. Omphalia has been found in all orchards where sampling has been carried out repeatedly. The largest number of samples required thus far to find a single Omphalia-positive palm on a property is 64.

7. Omphalia was obtained from 12 percent of all root samples taken from date palms.

8. Omphalia has been isolated with considerable greater regularity from palms of minor varieties than from Deglet Noor (Table I). With the exception of Medjhool, it has been obtained from all varieties where any considerable number of root samples have been taken.

9. Omphalia has been isolated from apparently healthy palms as well as from declined palms: 10 percent of apparently healthy Deglet Noor, 12 percent weak, 16 percent very weak. Even this slight correlation is not evident in the case of minor varieties (Table III).

10. Omphalia has been obtained from apparently healthy Deglet Noor palms in a considerable number of orchards in the absence of any evident decline symptoms. The fungi would appear to have been present in some of these for more than 15 years (Table IV).

11. Omphalia has been found on palms derived from every important importation, and in a solid stand of seedling date palms, and on *Phoenix sylvestris* grown from seed (Table VI).

12. No Omphalia was found in any of 73 root samples from the native palm, *Washingtonia filifera*.

13. In the two cases investigated (Gardens I and 0), attempts to eradicate Omphalia failed.

14. In the three experimental date plantings investigated (Gardens I, T, and X), Omphalia had been inadvertently introduced into the controls (Chart II).

15. The correlation between per-

Table V — Comparative Response of Deglet Noor and Khadrawy Palms to Water Shortage.

GARDEN C
Vigor, trunk height, and variety

o — leaky pipe line — o

							Avg. Height 13 yr. old	
			1924 Planting					
	.	.	.	.	x			
	DN	K	DN	K	DN	K	DN	K
Row 1	.	.	.	x	x	x		
	12	4½	6	0	2	0	6.7	1.5
	K	DN	K	DN	K	DN		
Row 2	.	.	.	.	.	.		
	5	13	5½	8½	4	3½	8.3	4.8
			1933 Planting					
	DN	K	DN	K	DN	K		
Row 3	.	.	,	.	x	.		
	9	4	3	5	3	3	5.0	4.0
	K	DN	DN	DN	DN	DN		
Row 4	.	.	.	.	/	/		
	4	28	26	27	22	24		
			1924 Planting					
Avg. Height of 13 year old palms								
DN	11.3		5.8		2.8		5.56	
K	4.5		3.5		2.3			4.1

Explanation: K—Khadrawy; DN—Deglet Noor. Height of trunk is the meosurement in feet from the ground line to the upper fiber line. Dot (.)—normal palm; line (/)—weak; cross (x)—very weak; commo (,)—recovering.

Table VI — Omphalia in Relation to Offshoot Importations.

Importation	Estimated % of Present Palm Population	Yield of Omphalia from Root Samples			Comments
		No. of Samples	Number Positive	Percent Positive	
ALGERIA					
1903	trace	10	3	30	Samples from old, neglected palms.
1911	trace	18	7	39	Samples from abandoned Rhars.
1912	45	101	12	10	From mostly apparently healthy "Yuma palms".
1913		no pure stands found			
1914	41	Gardens N, R, T, U, V			
1915		Gardens G, P, Q			
1922	2	Gardens K			
IRAQ					
1913	4	134	23	17	From mostly apparently healthy Persian palms.
EGYPT					
1921	1½	37	3	8	From apparently healthy Saidy and Hayany.
MOROCCO					
1927	trace	15	0	0	From apparently healthy Medjhool.
SEEDLINGS					
female	4	69	4	6	
male	2	46	9	19	

Information as to sources from the notes of B. L. Boyden, R. W. Nixon, and others, and Hilgardia (7).

cent of rotten roots in the samples taken and the isolation of Omphalia closely approaches and is not significantly different from zero.

16. Large decline areas (12 palms or more) have been noted on about two dozen properties. No exact number is given because of difficulty in definition. The majority of these are found in the Hundred Palms and High School districts and are commonly associated with heavy soils where water penetration and drainage are difficult.

17. Whenever a considerable number of root samples have been taken, Omphalia has always been found on properties where decline occurs, although sometimes the percent or root samples yielding Omphalia has been very low.

18. With, perhaps, the exception of Garden O, date decline has not been observed to spread within an orchard during the brief course of the survey. In Gardens G, V, and W the spread of decline appears to have reached definite limits long ago. In Gardens C, K, N, and P the decline areas appear to be shrinking, and marked recovery is evident for many of the palms. In Gardens B, D, E, F, M, and perhaps others, decline appears never to have spread from the original focal points.

19. Decline areas occur in Deglet Noor palms of the 1912 (property no. 56), 1914 (Gardens T, U, and V), 1915 (Gardens G, P, and Q), and 1921 (Garden K) importations from Algeria. These comprise the major importations of Deglet Noor.

20. Insufficient information has been obtained in regard to the destination of offshoots cut from orchards where decline occurs. It is evident that decline occurs in several orchards that received offshoots from Gardens Q and V. However, from Garden G (the type garden for date decline) and its sister Garden K, more than 5,000 offshoots have been traced. Less than three dozen of the resulting palms were graded as very weak. This is an excellent record for any orchard.

21. Deglet Noor appears not to be the only variety affected by decline, although the observations thus far have been rather confusing. Khadrawy and Zahidi appear to be fairly vigorous in a decline area in Garden T, yet, severe decline of Khadrawy and Zahidi occur in decline areas of Gardens C and Q, respectively. On property no. 15 the Saidy palms appear to be weaker than the Deglets; however, the orchard block involved appears to have been neglected.

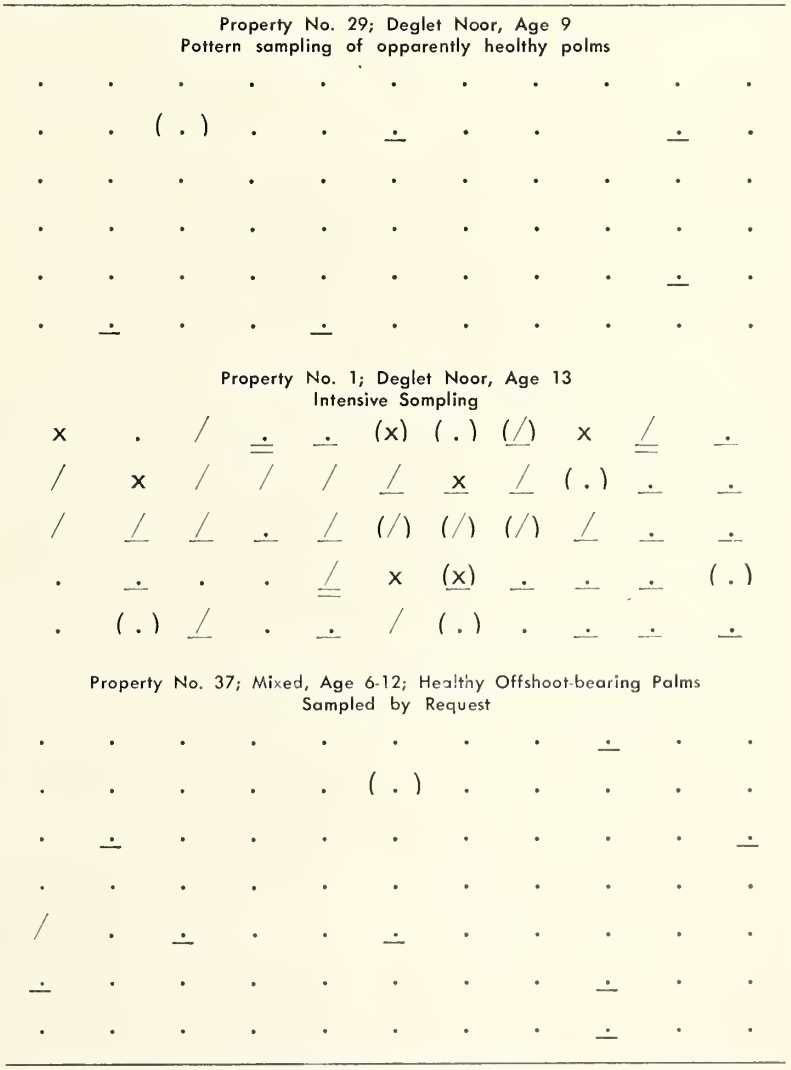
Discussion

Omphalia has been found on the roots of one or more palms on about 10 percent of the properties with date palms in the Coachella Valley. In the majority of the orchards where Omphalia was not found, relatively few samples were taken. Biometrists require odds of not less than 1 to 19 before they regard an event as significant. On this basis, calculating that about 10 percent of apparently normal palms yield Omphalia, failure to find Omphalia should not be considered significant unless at least 29 root samples have been taken[11]. In only two instances (properties 8 and 27) have that many samples been taken without finding Omphalia, and with further sampling these both yielded Omphalia: one out of 64, and one out of 62 samples, respectively. In pattern sampling, only about four percent of the palms are sampled, and of these perhaps 1/1000th part of the root system is examined. The possibility that Omphalia may be present in every orchard, and perhaps even on a majority of palms will be investigated by taking large numbers of samples in a few orchards. Omphalia occurs on palms derived from every important importation, and is especially prevalent on palms of minor varieties in the absence of above-ground symptoms. The possibility that Omphalia may be endemic will be investigated further.

If, as has been thought, Omphalia was introduced, and spreads little, if at all, through the soil in the absence of palm roots, it is evident that Omphalia has been present in a considerable number of orchards for 15 or 20 years or longer without having caused visible above-ground symptoms. The widespread occurrence of Omphalia in the Coachella

11. Ten percent positive equals one positive to 9 negative. Exponding the binomial 1 plus 9 to the 29th power we obtain odds of 4.7 to 95.3 which is approximately 1 to 19. For odds of 1 to 99, 44 root samples are required.

Chart I — Illustration of Charting and Sampling Procedure.



•—healthy; /—weak; x—very weak. Parentheses—Omphalia isolated. Underlined—root samples negative; two lines—sampled twice, both negative. Some were negative with the first sample but positive with the second.

Chart II — Omphalia in Relation to Experimental Plantings.

GARDEN T

			K	(K)	K	K	(K)	K	K	(K)	K	K	K		K	K	
						.	(.)	K	K		.	K	K	.	K	(K)	
.	(.)	.		.	.	.	.	.	.	.	.	.	.	(.)	.	.	(.)
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	(.)	.	.	
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
.	(.)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

North partion planted experimentally with presumed Omphalia-free offshaots 1933 (Hilgardia 16 (2): page 82). South portion planted about 1928.

GARDEN I

.	.	.	.	.	m	.	.	.	.
.	(.)		.	.	.	.		.	.
.		m	.	m	.	.	m	m	.
K	K	K	(K)	K	K	K	K	.	.

South row planted with presumed Omphalia-free offshoats 1933. (Hilgardia 16 (2): page 82).

GARDEN X
Control Block

Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
S	S	S	S	S	S	S	S	S	S
T	T	T	T	T	T	T	T	T	T
D	D	D	D	D	D	D	D	D	D
K	K	K	(K)	K	K	K	K	K	K
H	H	H	H	H	H	H	H	(H)	H

Planted with presumed Omphalia-free offshoots 1934. (Hilgardia 16 (2): page 45). SYMBOLS: .—Deglet Noor; D—Deglet Noor in variety planting; H—Halawy; K—Khadrawy; m—male; S—Saidy; T—Thoory; Z—Zahidi. Underlined palms were negative. Omphalia found on palms in parentheses. All palms regarded as appearing normal.

Valley covers a wide range of soil types, although it seems to be more difficult to obtain Omphalia from roots of palms growing in heavy, wet soil than elsewhere. On the other hand, even if one limits observations to specific instances where Omphalia has been alleged to be the cause (the alphabet gardens), date decline does not appear to be nearly so widespread, but does seem related to soil type: Date decline is most common in heavy soils where water penetration and drainage are slow, but also occurs in some instances on light soils where the moisture holding capacity is low. In Garden P and adjoining property no. 2, decline is confined to the northern blocks where the soil is heaviest, although offshoots for all blocks were home grown from palms of the 1915 importation. In Garden R, a hardpan interferes with water penetration. In Garden O, parts of the orchard are not well levelled with the result that water distribution is unequal. In one block of Garden C, the poorest palms are on loam overlaying coarse sand to a depth of only three feet. These palms have shown marked improvement with increased irrigation. The spread of date decline in Garden T was charted in Hilgardia (7). The water run is about 200 yards, which is double the usual length and perhaps three times the optimum length. Decline symptoms were first noted about 140 yards from its head and spread in a drought pattern. Excessive irrigation, at least in recent years, has been suspected of causing trouble in Garden Q where the soil in some areas is heavy, deep, and poorly drained. There, the initial decline area began along a pipe line, and there the Zahidi as well as the Deglet Noor variety is affected.

In the high school district, the possibility of a relationship between certain ecological factors and date decline has been considered. Postlethwaite noted that the best portions of Garden Q for palm culture are those where mesquite had covered the land before it was cleared (14). The manager of Garden O makes the same statement for that orchard. It will be noted that there is a particularly barren area on the desert adjacent to the decline area on property no. 48. However, this relationship between the occurrence of mesquite on the desert and palm vigor has not been reported by growers outside the area mentioned.

Economic losses attributed to Omphalia appear to be closely related to soil conditions and cultural care. To what extent palms might benefit by the absence of Omphalia is undetermined, because no significant evidence has yet been obtained that any planting is wholly free from it. The Deglet Noor variety is widely mentioned in the literature as being particularly sensitive to soil type, moisture supply, and cultural care. Certain other varieties appear to be more tolerant to adverse conditions. The Iteema palms observed have appeared vigorous wherever located. Khadrawy appears to be more tolerant of a low moisture supply, within limits, than is Deglet Noor (Table V). This is perhaps true of several other minor varieties, with Saidy as an exception.

The Omphalia Date Root Rot Project is confined to the discovery of *Omphalia* spp. on palm roots and any observations and techniques necessary to facilitate that procedure. This excludes the investigation of other troubles that may be confused with the disease called Omphalia root rot in expression of above-ground symptoms, and which appear to have caused considerable confusion in the survey. Further research on the date decline problem seems desirable. The State Department of Agriculture is not legally charged with research. This is a function of the University and of federal agencies.

Acknowledgments

The staff of the U. S. Government Date Garden is highly commended for providing temporary headquarters for the project, including office, laboratory, and greenhouse space. Grateful acknowledgment is made to Dr. S. S. M. Jennings for a gift to the project of 70 Deglet Noor offshoots, and to Howard Jennings for cutting the offshoots without charge; to the staff of the U. S. Entomological Field Station at Whittier for permitting examination of the notes of the Parlatoria Scale Eradication Campaign; to Mr. Roy Nixon of the U. S. Date Garden and Dr. D. E. Bliss of the Citrus Experiment Station for helpful criticism

and granting the use of unpublished notes; and to the fourteen Agricultural Inspectors that have served the project for various periods of time. The close cooperation of the growers with the project has greatly implemented its progress. A complete list of those who have contributed information as to sources of offshoots, or care of orchards, or have performed other services, would be too long to publish. However, thanks are especially due to L. Swingle, A. L. Cavanaugh, George Long, and C. Roy Hunter. Finally, we wish to commend our chief, Mr. D. G. Milbrath of the Bureau of Plant Pathology, State Department of Agriculture, for his keen interest and his cooperation in carrying out the project.

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THE FERTILIZER VALUE OF DATE LEAF AND FRUIT STALK PRUNINGS

By Tom W. Embleton and James A. Cook,[1] Division of Fruit & Vegetable Crops & Diseases, Bureau of Plant Industry, Soils, & Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

In past years most date growers have hauled old date leaves and fruit stalks from their gardens and burned them. Recently, mechanical choppers that cut the prunings into small pieces and return them to the soil have been used by a few growers. As a result of this practice, the question as to the value of these prunings as fertilizer has been raised. This investigation was conducted to determine the amounts of nitrogen, phosphorus, and potassium contained in leaf and fruit-stalk prunings.

Materials and Methods

Two old leaves which normally would have been removed during the summer pruning were obtained from Deglet Noor palms in each of seven date gardens in April 1946. These gardens represented the range of vigor of palm, from high to low, as found in the Coachella Valley. Since fruit stalks had been removed from most of the gardens at the time of sampling, it was possible to obtain them in only two of these gardens. A third sample of fruit stalks was obtained from one garden where leaves were not taken. Four representative stalks were used as a sample. After drying the entire leaves to approximately constant weight, thirty pinnae were removed from each leaf for analysis. Representative samples of rachises and fruit stalks were obtained by sectioning out material proportionately from all parts. After grinding, the samples were dried at 65° C.

Total nitrogen was determined by A. O. A. C. Methods. Samples were ashed at 450° - 500° C. for 8 to 10 hours and potassium and phosphorus were determined colorimetrically according to the procedures of Reitemeier (1). Calculations of the amounts of nitrogen, phosphorus, potassium, and organic matter returned per acre in leaf and fruit stalk prunings were based upon the assumption that there are 49 palms per acre, and that each palm produces 25 leaves and 15 fruit stalks annually.

(1) Formerly Junior Horticulturist and Scientific Aide, respectively.

Results and Discussion

Table 1 shows the percentages of nitrogen, phosphorus, potassium and ash found in the dry leaf material. The values shown for the whole leaf were derived by calculation from those for the pinnae and rachis. In these old leaves the percentages of nitrogen were about four times as great in the pinnae as in the rachis, but the potassium content of the rachis was about four times that of the pinnae.

In all of the gardens the nitrogen, phosphorus, and potassium content of old leaves was low in comparison with that of younger leaves. Analyses made by Reuther (2) of Deglet Noor leaves taken from the region of the inflorescences indicate that normal healthy pinnae on such leaves usually contain from 1.7 to 1.9 percent total nitrogen, 0.10 to 0.12 percent phosphorus, and 0.8 to 1.0 percent potassium. On the other hand the ash content of the pinnae of old leaves was high (16 to 22 percent) and that of young pinnae low (8 to 11 percent).

It appears, as has been found in many other plants, that as the leaves age the percentages of nitrogen, phosphorus, and potassium decrease, partly as a result of transfer of these elements to younger tissues, and partly becausc of increase of other materials, such as cellulose, lignin, and silica.

The results of the analyses of the fruit stalks persented in table 2 show that the percentages of nitrogen and phosphorus in the fruit stalk were similar to those of the rachis, but the potassium content of the fruit stalk was unexpectedly high.

Table 3 presents the data of Tables 1 and 2 converted to terms of pounds per acre. These values were calculated from the estimated dry weight of the leaves and fruit stalks produced annually by an acre of palms. It is evident that the amount of nitrogen and phosphorus returned to the soil is small. If the current prices for nitrogen, phosphorus and potassium of 11, 17, and 9 cents per lb., respectively, are used, the value of prunings may be estimated to be about $9.70 per acre. This figure, however, does not represent a true value, inasmuch as it is not likely that date palms in the Coachella Valley require fertilization with either phosphorus or potassium.

The value of the nitrogen alone is about $2.50. In soils in which organic matter is needed to maintain good soil structure, it is probable that the organic matter is the most valuable constituent of the prunings. Prunings from an average date garden probably supply about 4800 lbs. of dry matter per

Table 1.—Nitrogen, Phosphorus, Potassium, and Ash Content of Pinnae, Rachis, and Whole Leaf of Deglet Noor Date Palm. (Percentages Based on Dry-Matter.)

		PINNAE				RACHIS				WHOLE LEAF			
Garden	Leaf Sample	N	P	K	Ash	N	P	K	Ash	N	P	K	Ash
A	1	1.13	.043	.26	20.1	.28	.024	.92	6.65	.61	.031	.66	11.9
	2	.91	.033	.19	21.0	.28	.019	.97	7.72	.55	.025	.64	13.3
B	1	1.21	.065	.21	16.1	.30	.024	.75	6.55	.66	.040	.53	10.4
	2	1.06	.054	.19	16.9	.24	.022	.75	6.27	.57	.035	.52	10.8
C	1	.76	.037	.22	25.9	.22	.027	.83	9.76	.44	.031	.58	16.4
	2	.82	.036	.18	22.9	.23	.025	.80	9.76	.48	.029	.54	15.3
D	1	1.02	.043	.23	17.4	.20	.019	.82	5.72	.50	.028	.60	10.0
	2	.93	.044	.20	17.1	.20	.019	.74	6.55	.49	.028	.53	10.7
E	1	.82	.065	.17	22.9	.19	.059	.70	7.80	.45	.062	.48	13.9
	2	.82	.065	.21	21.1	.20	.058	.72	7.81	.46	.059	.50	13.5
F	1	.67	.045	.19	17.1	.18	.033	.86	6.07	.40	.038	.58	10.8
	2	.80	.052	.18	17.7	.19	.030	.76	6.50	.44	.040	.53	11.0
G	1	.74	.046	.17	22.7	.21	.021	.46	5.99	.42	.031	.35	12.6
	2	.79	.058	.17	20.3	.20	.025	.44	4.78	.44	.039	.33	11.0
Average		.89	.049	.20	19.9	.22	.029	.75	6.99	.49	.037	.53	12.2

acre to the soil. About 10 or 11 percent of this is ash.

It is estimated that the amount of dry matter produced per acre from date prunings is considerably greater than that returned by the average *Melilotus indica* cover crop. The nitrogen content of prunings is, however, considerably less than that usually found in sweetclover, so that the value of prunings as a nitrogen fertilizer is probably less than that of a good sweetclover cover crop. What is probably of greater importance than the amount of nitrogen in the prunings is the low proportion of nitrogen to carbon. According to Waksman (3), when plant residues contain about 1.7 percent nitrogen, there is just sufficient nitrogen for microorganisms to bring about active decomposition of the material.

When materials, such as date prunings, that contain less than 1.7 percent nitrogen are added to the soil, it is considered advisable to add sufficient inorganic nitrogen to raise the nitrogen content of the material to at least 1.7 percent. Since the nitrogen content of date prunings is only about 0.5 percent, about 58 pounds of nitrogen per acre would have to be added to raise the nitrogen content of 4800 pounds of prunings to the desired level. Whether in actual practice the supplementary nitrogen would be effectively used by the microorganisms is questionable, since much of the added nitrogen might be leached below the surface soil in which the prunings were incorporated before decomposition had progressed very far. It seems unlikely in any case that under the common practice of adding two or three pounds of inorganic nitrogen per palm per year, the palms would suffer nitrogen deficiency as a result of nitrogen assimilation by the organisms involved in the decomposition of the prunings.

Summary

Prunings of date leaves and fruit stalks from eight date gardens were analyzed for nitrogen, phosphorus, and potassium. Leaves were found to contain 0.40 to 0.66 percent nitrogen, 0.025 to 0.062 percent phosphorus, 0.33 to 0.66 percent potassium, and 10 to 16.4 percent ash. Fruit stalks contained 0.28 to 0.42 percent nitrogen, 0.017 to 0.040 percent phosphorus, 3.46 to 4.94 percent potassium, and 7.7 to 9.88 percent ash. It was calculated that prunings from an average garden would supply approximately 4800 lbs. of dry matter containing 23 lbs. of nitrogen, 1.77 lbs. of phosphorus, and 66 lbs. of potassium. The prunings will probably supply more organic matter but less nitrogen than is produced by the average cover crop.

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Table 2.—Nitrogen, Phosphorus, Potassium, and Ash Content of Fruit-Stalk of Deglet Noor Date Palm. (Percentages based on Dry-Matter.)

Garden	Stalk Na.	N	P	K	Ash
A	1	.36	.029	4.41	8.69
	2	.36	.023	4.50	8.95
	3	.39	.027	4.94	8.66
	4	.37	.017	4.59	9.15
G	1	.42	.021	4.44	9.88
	2	.33	.021	3.46	9.75
	3	.39	.025	4.46	7.70
	4	.39	.035	4.40	9.00
H	1	.31	.040	4.51	9.35
	2	.33	.037	4.34	8.60
	3	.28	.036	4.17	8.76
	4	.31	.025	4.00	8.40
Average		.30	.028	4.35	8.91

Table 3.—Estimated Amounts (Pounds) of Nitrogen, Phosphorus, and Potassium in Leaf and Fruit-Stalk Prunings per Acre of Deglet Noor Palms*.

	Leaves				Fruit Stalks				Tatal Leaves & Stalks			
Garden	Dry Weight	N	P	K	Dry Weight	N	P	K	Dry Weight	N	P	K
A	5100	30	1.4	33	1050	3.9	.26	49	6250	34	1.7	82
B	4300	26	1.6	23								
C	4200	19	1.2	23								
D	3900	20	1.1	22								
E	3600	16	2.2	17								
F	3000	12	1.2	16								
G	2200	10	0.8	8	900	3.4	.23	37	3100	14	1.0	45
H					1200	3.7	.43	52				
Average	3760	19.0	1.46	20.3	1050	3.7	.31	46	4810	22.7	1.77	66.3

* Values reparted are raunded numbers.

IMPORTATIONS OF DATE OFFSHOOTS AND THE MEN WHO MADE THEM

By Roy W. Nixon, Associate Horticulturist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

Although seedling dates have been grown in the Western Hemisphere since the early Spanish settlements, the establishment of a commercial date industry in the United States is the direct result of importations of offshoots of the better varieties of dates already developed through centuries of selection in the Old World. In 1890 the United States Department of Agriculture arranged through correspondence for a small importation of date offshoots from the Old World, but these later proved to be inferior sorts. To obtain the desired varieties it was necessary for plant explorers of the U. S. Department of Agriculture and representatives of prospective date growers to go to the more important date-growing regions of North Africa and Iraq and personally supervise the selection and shipment. The names of the men who made such importations of date offshoots are listed below in chronological order, with the principal varieties imported and the countries from which they were obtained.

Experimental Importations by the U. S. Dept. of Agriculture

Walter T. Swingle. 1900: Deglet Noor and Rhars from Algeria.

Walter T. Swingle. 1927: Medjhool from Morocco.

David Fairchild. 1901: Hayany from Egypt.

David Fairchild. 1902: Halawy, Khadrawy, Maktoom, Sayer, and Zahidi from Iraq; Apdandon, etc., from Baluchistan.

Thomas H. Kearney. 1905: Menakher, Areshty, Kenta, etc., from Tunisia.

Silas C. Mason. 1914: Saidy from Egypt.

Roy W. Nixon. 1929: Amir Hajj, Bedraya, and Bagdad Khadrawy from Iraq.

Commercial Importations by Date Growers

Bernard G. Johnson. 1903, 1908, 1912, 1913, 1914, 1915: Deglet Noor from Algeria.

Herschel F. Cole. 1911, 1912, 1913: Deglet Noor from Algeria.

Paul Popenoe (assisted by his brother, Wilson). 1913: Barhee, Dayri, Halawy, Khadrawy, and Zahidi from Iraq; Khalasa from southeastern Arabia; Deglet Noor from Algeria.

Silas C. Mason. 1920 and 1922: Hayany and Saidy from Egypt.

Silas C. Mason. 1921: Deglet Noor from Algeria.

While the Annual Date Growers Institute is primarily concerned with current problems of the industry, the committee in charge of the program considers it worth while to incorporate in the Reports from time to time, as opportunity and space permit, papers dealing with the early history of date culture in the United States. It is hoped that articles can be written by or about each of the persons who made importations of offshoots. It is especially appropriate that the man who made the first successful personally supervised importation of known varieties of date offshoots should begin the series. Dr. Walter T. Swingle not only was the first plant explorer of the U. S. Department of Agriculture to search for date varieties abroad, but he made the first critical study of climatic and soil conditions in the Southwest and showed, by comparison with conditions in the date growing regions of the Old World, that the most promising locality for date culture in the United States was the Colorado Desert. It was under his direction that the first Federal date experiment station was established in Coachella Valley in 1904 and he was in charge of date investigations for the U. S. Department of Agriculture for more than three decades.

THE FIRST SUCCESSFUL INTRODUCTION OF STANDARD VARIETIES OF DATE PALMS INTO THE NEW WORLD

By Dr. Walter T. Swingle, Collaborator, Bureau of Plant Industry, U. S. D. A., Washington, D. C.

In the spring of 1898, I was working in the International Zoological Station at Naples, where I occupied the Smithsonian Table. I happened to be there at the season when the fig flowers were being caprified by the natives, and found out from them that they considered caprification absolutely essential for many of the best figs that grew in this part of Italy.

The caprifig carries small numbers of fruits through the winter on branches from which the leaves have fallen, and these small fruits are very firm and do not open until late in March. The Blastophaga insects completely fill these fruits, so I wrapped tinfoil around a few of these caprifigs and sent them by mail to California, hoping the insects would escape in time to lay eggs in the young caprifigs of the spring generation, of which the trees bear thousands. These figs ripen in June and, unlike the winter generation, are soft and pulpy, and the Blastophaga insects escape and enter into the young edible figs, pollinate them and cause the fruit to set. No caprified figs had been produced in California except a very few artificially pollinated by Dr. Eisen, connected with the Academy of Science at San Francisco.

The figs I sent from Naples in 1898 arrived too late, but the next year I was travelling for the Department of Agriculture in North Africa and found by personal examination that the winter generation of caprifigs ripened as early as February in the Saharan oases and by the middle of March in Algiers. I was able to ship caprifigs from the vicinity of Algiers. They were still firm and wrapped in tinfoil. This time they reached California at the proper season, and thereby established the culture of the fine Smyrna figs that had been introduced on a large scale by Governor Stanford some twenty years before but had up to then never fruited. Only a few fruited in 1899 but early in the autumn I found countless thousands of Blastophaga insects flying about in the fig orchards. This led to the rapid establishment of Smyrna fig culture in California and some ten or twelve thousands of tons of caprified figs were soon produced every year by the fig trees introduced from Smyrna.

While studying figs in Biskra, Algeria, in 1898, I became very interested in the date palms grown there on a large scale. This was the first time I had ever seen commercial date culture. I learned that a French company had large plantings at Ourlana, about 125 miles south of Biskra, in an irrigated oasis. I went to the sales office of this company to inquire about dates and their culture. The salesman in charge was not interested in explaining about date culture, as he was selling dates, and as I did not buy any, he closed the window right in my face.

In the spring of 1899 I did, however, ship to America a half-dozen Deglet Noor date palms which had been rooted in tubs at Algiers. They were shipped to Phoenix, Arizona but a year later were moved to Tempe. Unfortunately not enough leaves were cut off when they were planted out and the palms all died.

In 1899, returning from California to Washington, I stopped off for several weeks at the University of Arizona in Tucson, and had the great pleasure of becoming well acquainted with Professor Tuomey, who was then Director of the Arizona Agricultural Experiment Station. He had just published an excellent, very full report (Arizona Expt. Sta. Bulletin No. 29) on the behavior of the date palm in Arizona and California. Professor Tuomey based his report on the collection of offshoots imported from Egypt in 1889-90 by H. E. Van Deman, Chief of the Division of Pomology of the Department of Agriculture. These offshoots had been secured by correspondence with the American Consuls at Cairo, Mascat and Algiers. Nine were from Algeria, six from Mascat and fifty-six from Egypt. Many of these were males but carried the names of famous varieties. They were obviously mislabeled, as were also most of the fruit-bearing palms. Some of these palms bore edible fruit and proved that dates could be grown in Arizona and would fruit abundantly. There were also seedlings growing in California, Arizona and Mexico.

Professor Tuomey and I talked repeatedly about what I had seen of the date culture near Biskra. Finally we thought up a plan to introduce enough palms of standard varieties to make a thorough test of date culture in Arizona and California. He, as Director of the Agricultural Experiment Station in Arizona, agreed to establish a date introduction garden where they would take care of the propagating and cultivating of date varieties; the Department of Agriculture would pay all of the expenses of foreign travel, purchase of offshoots, packing and shipping them to the site of the date introduction garden established by the University of Arizona at Tempe.

I reached France in the spring of 1900 and, still smarting from my embarrassment at the window being shut in my face in Algiers, when I had asked for information about dates, I put on my top hat and frock coat and called at the Paris office of the largest date growing company in Algeria. The head of the com-

pany was Monsieur Foureau, the brother of the famous French explorer, F. Foureau, who at that time was making the first trans-Saharan military expedition, after more than twenty years exploration in North Africa.

I told Monsieur Foureau that I would like to have the help of his company in North Africa in obtaining offshoots for trial at the newly established date garden in Arizona. Fortunately I mentioned that from this garden we expected to supply California with a complete collection of the varieties we secured. At this point he interrupted me and said, "Now that you mention California, I will tell you that I have a very warm spot in my heart for California. When I was a young man my mother sent me around the world in the hope of building up my health, which at that time was bad and continued bad until I reached California. There I recovered rapidly the health which I have never lost since, and I am profoundly grateful to California for this priceless gift." He thereupon wrote three letters, as President of the Company, to his three leading employees of the Algerian date plantings. He also wrote personal letters to all three, endorsing me most warmly and asking them to do everything they could to help me.

The oldest and most experienced employee was a Frenchman over eighty years old, who spoke and wrote Arabic, and Monsieur Foureau asked him to accompany me into the plantings at Ourlana, about 125 miles south of Biskra. This was asking a good deal of an old man, as we started south from Biskra about the middle of May. The weather was already very hot and my companion was unable to travel in the daytime. We had to travel at night when the weather was still cool, and to sleep in the daytime in the thick-walled forts where the French travellers spent the night, protected against enemy raids. When we reached Ourlana, I bought several hundred date offshoots, had their leaves trimmed, put them in bags and had them ready for shipment by camel caravan to Biskra, where the railroad would carry them to Algiers. At this moment the French Military Government seized all of the camel caravans in that part of the Sahara, because of threatened rebellion by some of the fighting natives who had not as yet accepted French rule!

This was the height of misfortune for me, for I would have to go home, the government money all spent, with no offshoots, as they would all die soon in the heat of the desert. This was where the help of the old man who knew the Arabs well proved invaluable. He began at once to write notes in Arabic and sent them by messengers on swift horses to the heads of all of the nearby villages, asking for camels not yet seized by the French Government. Within a few hours, he located some fifteen or twenty camels and the whole world looked better to me, because after I had engaged camels they would not be seized by the Government until they finished the trip to the railroad station at Biskra. They arrived there two and one-half days later, on the 21st of May 1900. The offshoots were then packed in a specially chartered freight car and shipped through to Algiers. There they were given a final trimming prior to shipment to New York.

Here I met with another disappointment almost as grave as the seizure of the camels by the French Government. Heretofore the few offshoots shipped to America had been sent in tubs partly filled with earth. The Captain of the freight steamer told me this was dangerous for such a large shipment because in case of a storm, tubs might break loose from their fastenings and roll all over the deck of the ship and do much damage. He would not carry them for less than 38 shillings, nearly $9.00 apiece. I could not possibly pay such a freight bill. Thus, necessity became the mother of invention; I devised a new system of packing. I telegraphed to Paris to my friends in the Vilmorin-Andrieux and Company, who had operated the largest seed firm in France for over 100 years, asking them to send me at once a few small bales of sphagnum. I put in a couple of handfuls of moist sphagnum at the base of each offshoot and tied it with rye straw bought in the market and banana petioles stripped from old banana trees in the Botanic Garden. Then I bought shipping crates which had been used to ship shoes to Algeria. We found that these crates would hold about twelve to fifteen offshoots, and the freight on *each crate* was only thirty-eight shillings! So this made it possible to ship them safely and with much easier handling.

The shipment reached New York on July 3, and was thereupon shipped free of all charge by the Southern Pacific Railroad Company, through the Morgan Line Steamship, which they controlled, to New Orleans, and from New Orleans to Tempe, Arizona by rail. This shipment from New Orleans to Tempe was made in a freight car but the freight car was attached to a passenger train, so the offshoots travelled at express speed and reached Tempe on July 17.

Professor Tuomey had gone to Yale University to accept a position in the newly established School of Forestry. Professor R. H. Forbes, who succeeded him as Director of the Arizona State Experiment Station, at once took charge and unpacked and fumigated the 447 offshoots which I had shipped from Algiers. He planted 391 of them at Tempe Date Garden (which had just been established); 21 at the older date garden at Phoenix, and sent 35 to California to addresses which I furnished him. Eighty-seven of the offshoots planted at Tempe were of the famous Deglet Noor variety. This was the first successful introduction of offshoots of standard date varieties into the new world, just 400 years after the first ship touched the shores of South America in 1500.

Professor Forbes reported (Arizona Agr. Expt. Sta. 12th Ann. Rpt.) that in the autumn of 1901 75% of the offshoots were growing, 11% were doubtful and 14% were dead. This is about the percentage the Arabs told me they expected when they planted the offshoots immediately. After this all offshoots imported into the United States were packed in crates instead of tubs.

At next year's Date Institute I hope to discuss the amazing record of the government date experts in securing offshoots of more than 100 of the leading varieties of dates from the principal date regions of the world.

But without the painful acquisition of our present skill in growing offshoots, pollinating, curing and handling the fruit, the industry would not have been established at all. The eradication of the Parlatoria scale in the late twenties, at a cost to the Federal government of more than three quarters of a million dollars, marks the end of a crisis which would have destroyed the industry. Differential pollination, causing early flowering bunches to ripen late and late flowering bunches to ripen early is becoming more and more important as date culture is extended into new areas. The work of the California Experiment Station in discovering, studying and controlling date diseases and insects, is of paramount importance.

The Date Institute itself, begun in 1924 and held every year since with published proceedings, controlled by a committee of date growers, with the cooperation of Federal and State officials, will continue to carry the torch and undoubtedly lead to profound changes in date culture the world over.

CAN A DATE PALM CARRY TOO MANY LEAVES?

By Roy W. Nixon, associate horticulturist, Division of Fruit & Vegetable Crops & Diseases, Bureau of Plant Industry, Soils & Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, Indio, California.

Introduction

In 1941 two pruning experiments were started to determine whether it is beneficial to leave on a date palm all the leaves it can carry as compared with the practice then common of pruning to clear the bunches. Few palms at that time carried more than 120 leaves before being pruned and no record was available as to the maximum number of green leaves that a palm might support under favorable conditions. A preliminary report covering the first two years of work was presented in 1943 at the 20th Annual Date Growers Institute. During this period the retention of more leaves resulted in the production of more inflorescences and in higher yields on the unpruned palms than on the pruned palms. This more than offset a slight tendency for a higher percentage of the better grades of fruit on the pruned palms. The 1943 results did not materially change the situation, but since that time there have been no significant differences in yield. As the number of green leaves carried by the unpruned palms continued to increase after 1943, the question has arisen as to whether a date palm can carry more leaves than are conducive to maximum production of fruit.

Location and Plan of Experiments

These experiments were carried out in cooperation with Coachella Valley date growers. One set of plots was located in the Kenneth Peck garden near the Coachella Valley Union High School and the other set in the H. L. Cavanagh garden in the Indian Wells district. During the course of the investigations the Cavanagh garden was sold to Gwynn Wilson and in this report the property will be referred to under the name of the present owner. All of these men have cooperated in every way possible and without their help the investigations could never have been undertaken. Grateful acknowledgment is also made to D. H. Mitchell and the Coachella Valley Fruit Co. for their cooperation in carrying out a six-year study of leaf-fruit relationships, to which brief reference is made in this paper.

In each of the two pruning experiments there were 20 Deglet Noor palms. These palms were 15 years of age when the tests were begun. Alternate palms were pruned to clear the bunches. On the other palms no leaves were pruned except for a few (6-8) that were removed because of serious interference with bunches or bags. Except for the first pruning in June of 1941, all pruning of green leaves was done in August prior to bagging. Fruit thinning and other cultural practices were left to the growers. They handled the test palms the same as the rest of their palms. The number of leaves, inflorescences, and bunches, and the yields have been recorded yearly for each palm. Fruit that dropped was not included until 1943 in the Peck garden and 1944 in the Wilson garden. This fruit in the Wilson garden has accounted for 10 to 15 percent of the total yield except in 1945 when it was about 75 percent. The record in the Peck garden is similar, but the percentage of dropped fruit was slightly less than in the Wilson garden. The 1945 yield in the Peck garden was estimated because prior to the first picking the bunches were shaken to remove spoiled fruit of which no record was obtained. From one or two of the principal pickings each season representative lots of fruit have been graded.

RESULTS

Effect of Number of Leaves Upon Yields

Average palm yields and number of leaves after summer pruning for the Peck garden are shown in Figure 1. On the pruned palms leaves were removed to clear the fruiting area of the bunches. The exact number of leaves removed per palm varied because of differences in the number of bunches, in the way the bunches were tied down, and in the length of the fruitstalks. The average number of leaves left per palm after pruning, however, was close to 100. On the unpruned palms the average number of leaves reached a peak of about 150 in 1944. Yields of the unpruned palms were higher for the first two years, although the difference was not significant except in 1942. Fruit production reached a peak of almost 350 pounds per palm in 1944, then declined for the last two years. Apparently the high yields in 1944 overtaxed the capacity of the palms. Yet, based on other records mentioned later, the ratio of leaves to number of bunches or to pounds of fruit produced on the unpruned palms was not in excess of that which has been satisfactory for palms carrying fewer leaves. The fact that the unpruned palms dropped in production just as much as the pruned palms in spite of having 50 percent more leaves may be taken as evidence that these older leaves are not as efficient in fruit production as the younger leaves The fact that yields dropped for two years in succession also suggests that some factor other than the ratio of leaves to fruit may have been involved.

The corresponding record for the Wilson garden is shown in Figure 2. The average number of leaves per palm left after pruning was about the same as in the Peck garden. On the other hand, the number of leaves on the unpruned palms continued to increase throughout the 5 years until in 1946 there was an average per palm of 183 green leaves before pruning and 179 after pruning. This probably represents the maximum they will carry as the average number of leaves that died during the year prior to the 1946 pruning was 23 per palm and the records show that this is very nearly the number the palms are producing yearly. Yields of the unpruned palms were significantly higher than those of the pruned palms in both 1942 and 1943. After that there was no consistent difference between treatments, although in 1946 there were almost twice as many leaves on the unpruned as on the pruned palms and the general trend for all palms was upward. It seems likely, therefore, that if the retention of old leaves had been stopped after the unpruned palms had acquired between 140 to 150, this treatment might have continued to give consistently higher yields than were obtained from the pruned palms. The lack of any significant difference in yields after the number of leaves was higher than this, suggests that these excess leaves may actually have had a depressing influence on fruit production.

Relationship of Pruning to Fruit Quality

Although there was slightly more dry fruit on the unpruned palms than on the pruned palms in 1942, no pronounced differences in grades appeared until 1946. There were 3

Fig. 1. — Average Yield per Palm In Relation to Number of Leaves— Peck Garden.

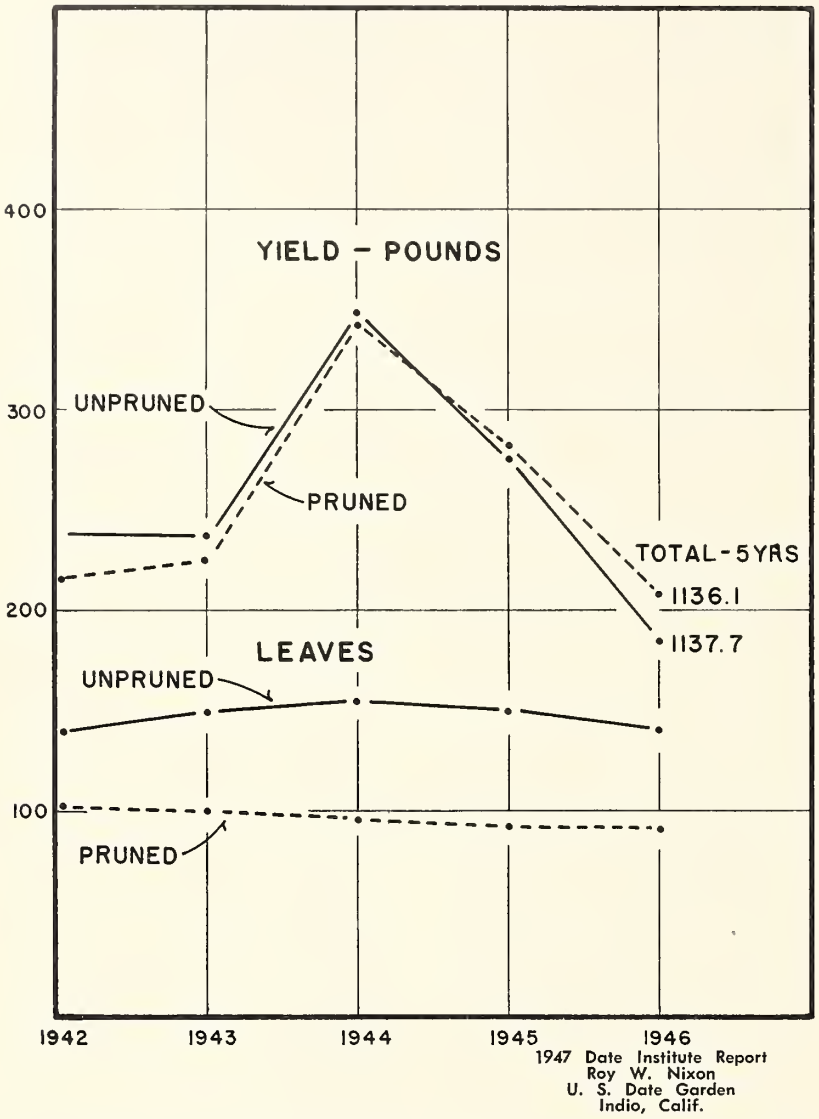


Table 1. — Grade Record of Fruit in 1946 Crop (Percent.)

PECK GARDEN	B or higher	C (No. 1 dry)	D (No. 2 dry)	Culls
Pruned	58.3**	23.8**	13.1*	4.8
Unpruned	44.5**	30.3**	20.1*	5.2
WILSON GARDEN				
Pruned	60.8*	26.6	10.1	2.5
Unpruned	49.1*	32.5	14.4	4.4

Two asterisks ** indicate significance of the difference between treatments at the 1% level and one asterisk *, at the 5% level, as determined by Student's method.

Table 2. — Average Percentage of Fruit Affected with Blacknose.

PECK GARDEN	1943	1944	1945	1946
Pruned	.....	15.5	32.2	35.2*
Unpruned	.....	19.9	33.9	45.1*
WILSON GARDEN				
Pruned	26.7	11.5*	87.3	15.1*
Unpruned	25.9	20.0*	92.2	24.2*

* Difference statistically significant at 5% level.

pickings this season in the Peck plots and 4 in the Wilson plots. Grade records of the second pickings are shown in Table 1. The fruit is believed to be representative for the season. Fruit from the Peck garden showed significant differences in favor of the pruned palms, which had more B grade or higher and less C and D (No. 1 and No. 2 dry) grade than the unpruned palms. In the Wilson plots fruit from the pruned palms also graded out better than that from the unpruned palms, but the differences were significant only for the soft fruit.

Differences in blacknose prior to 1944 were not apparent when the yields were recorded in the field, so no special examinations were made except in the Wilson garden in 1943. For the last three years random lots of fruit from each palm in both gardens were graded for blacknose. The percentages of fruit affected with blacknose are given in Table 2. There was consistently more blacknose fruit on the unpruned palms than on the pruned palms during the last three years, although the differences were just barely of statistical significance in 1944 in the Wilson plots and in 1946 in both.

Effect of Leaf-Bunch Ratios Upon Development of Inflorescences

When fruit production overtaxes the bearing capacity of a palm a reduction in the number of inflorescences usually follows the next spring. Hence, a measure of the extent to which pruning treatments have affected the bearing capacity of a palm may be obtained by comparing the number of inflorescences produced the following season. A comparison of the number of leaves per bunch and of the number of pounds of fruit per leaf one year with the number of inflorescences that appeared the following year in each treatment of the two gardens is given in Table 3.

In the Peck plots there was only one year when the difference in average number of inflorecsences per palm between the two treatments was significant. The pruned palms had a leaf-bunch ratio of 6.2 in 1941 and produced 13.7 inflorescences per palm the following season, whereas the unpruned palms had a leaf-bunch ratio of 9.6 in 1941 and produced 16.6 inflorescences per palm the following season. The number of pounds of fruit per leaf in the first year is not known because of heavy unrecorded losses from rot. In later years there were differences in leaf-bunch ratios nearly twice as high as this, but apparently the lowest ratio was not

low enough to be a limiting factor in influencing production. The peak of fruit production in this experiment was reached in 1944 with 3.6 pounds per leaf on the pruned palms and 2.3 lbs. per leaf on the unpruned palms, but the higher proportion of leaves on the unpruned than on the pruned palms was of no apparent benefit as both treatments showed about the same decrease in number of inflorescences the following year. A ratio of 2.3 lbs. per leaf should not have overtaxed the palm if the old leaves had been as efficient as the young leaves. As mentioned later, palms comparable as to age and vigor have borne 3 lbs. or more per leaf without a reduction in number of inflorescences the following year. In the Peck plots there was a continuous decline in number of inflorescences on the unpruned palms from 1942 until 1946.

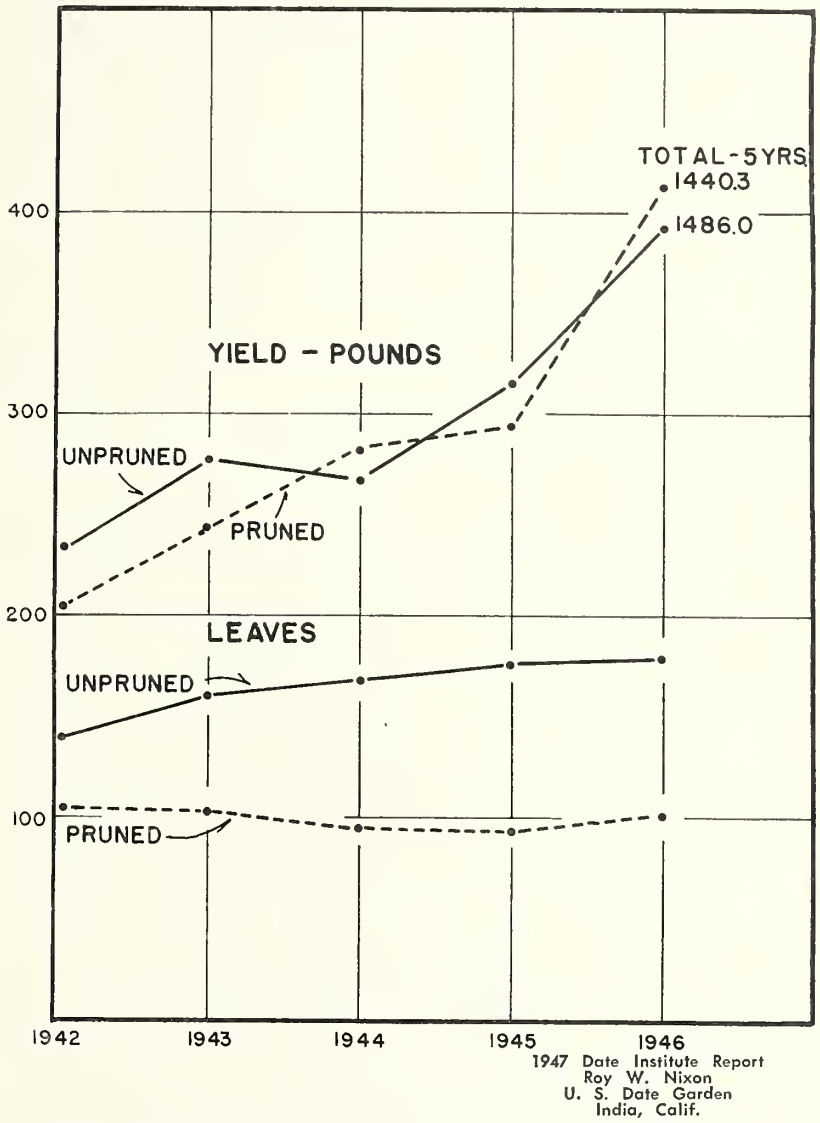
In the Wilson plots there were four years when leaf-bunch ratios of 7 or below on the pruned palms were followed by a significantly lower number of inflorescences than that on the unpruned palms. These differences may be attributed to the higher ratios of leaves to bunches and to fruit on the unpruned palms. But if there had been as many as 9 leaves per bunch on the pruned palms there is no reason to believe the number of inflorescences the following year would have been lower than on the unpruned. Except for a slight drop in 1944, there was an increase in number of inflorescences produced on the unpruned palms from 1942 until 1946.

Typical and comparable leaves were measured on each palm in the two gardens to determine leaf area. Leaves in the Peck garden were slightly larger, averaging about 25 sq. ft. of leaflet area (one surface) as compared with about 23 sq. ft. of leaflet area in the Wilson garden. This apparently has no relation to any differences observed between the two gardens, although it should have made possible a slightly higher production of fruit per leaf in the Peck garden than in the Wilson garden.

Observations in Other Gardens

As a check on current pruning practices in relation to flowering and yields, systematic observations were made in ten different Deglet Noor date gardens in various parts of Coachella Valley from 1943 to 1946. Blocks of 10 to 12 palms, ranging in age from 12 to 20 years, were selected in each garden. Each year counts were made of the inflorescences produced and bunches carried, and an estimate was made of the number of leaves per palm. Among the gardens selected were some that were above the average of Coachella Valley and a few that were below.

Fig. 2. — Average Yield per Palm In Relation to Number of Leaves— Wilson Garden.



Most of the pruning in these gardens was done at the time of bagging. In the 6 best gardens the estimated number of leaves left after pruning varied from 90 to 125. The size of the leaves indicated that these palms were vigorous. The leaflet area in the different gardens averaged from 23 to 27 sq. ft. per leaf. During the 4 years of observation the average number of leaves per bunch after bagging ranged from 5 to 9, which was estimated to correspond to 4.7 to 2.7 lbs. of fruit per leaf. At various times leaf-bunch ratios as low as 6 were observed in 4 of these gardens, but in each instance there was a reduction in number of inflorescences the following spring. These low leaf-bunch ratios occurred with an estimated fruit production of 4 lbs. or more per leaf.

In the other four gardens the number of leaves after summer pruning varied from 75 to 100. Lower vigor of the palms was indicated by the smaller leaves, the average leaflet area of which ranged from about 23 to 19 sq. ft. per leaf. Leaf-bunch ratios after bagging ranged from 5 to 15, but in these gardens there was no consistent pattern in leaf-fruit relationships. In the poorest of the ten gardens the average number of inflorescences per palm decreased for two years in spite of high leaf-bunch ratios and very low production of fruit per leaf; then, following a change in ownership and an improvement in cultural management, there was a large increase in number of inflorescences in 1946. In another garden an increase in the amount of water applied was followed the next year by an increase in the number of in-

florescences. Apparently in some of these low-vigor gardens factors other than the ratio of leaves to fruit were limiting production.

Additional data bearing on the problem have been obtained from a study of leaf, bunch, and fruit relationships in cooperation with D. H. Mitchell and the Coachella Valley Fruit Co. In these experiments individual records of 60 Deglet Noor palms, 7 years of age at the start, were kept for 5 years. There were treatments with 6, 7.5, 9, and 11 leaves per bunch, all bunches being uniformly and moderately thinned. These ratios were attained primarily by removing bunches at the end of the pollination season. The retention of practically all the bunches produced was neeessary to get a ratio as low as 6 and after two years the number and size of the inflorescences was so reduced that the number of leaves per bunch was changed to 13 in this treatment. Maintaining a ratio of 7.5 leaves per bunch also caused some reduction in the number of inflorescences appearing the following year, and in two of the five years there were so few that the ratio had to be raised to 11. The lowest ratio that could be maintained throughout the 5 years was 9 leaves per bunch. The maximum production in this treatment was about 2 pounds of fruit per leaf. A slight reduction in total yield was the chief difference that resulted from maintaining a leaf-bunch ratio of 11 as compared with 9. The total fruit production for the five year period showed no significant difference in yield or grade between palms that had 7.5 leaves per bunch for three of the five years and those that had 9 leaves per bunch for the entire period. It is believed that the bearing capacity of this garden was adversely affected by underirrigation during part of the experiment and by being interplanted with citrus. Furthermore the palms were not old enough to be in full bearing until about the end of the experiment.

Discussion

The results of these experiments suggest that the most serious consequence of retaining leaves in excess of 140 to 150 per palm was the lower grade of fruit that resulted from an increase in the percentage of blacknose and dry fruit. A possible explanation of the increase in blacknose is that on the unpruned palms the large number of leaves below the bunches increased the relative humidity around the fruit during midsummer. In the gardens in which the pruning experiments were conducted it is the practice after the beginning of harvest to reduce the amount and frequency of application of irrigation water. The large number of leaves on the unpruned palms then probably competed with the fruit for a reduced supply of water and dry fruit resulted.

In both the Wilson and the Peck gardens the yield of fruit per bunch usually averaged slightly less on the unpruned palms than on the pruned palms. In searching for an explanation of this, it was noted that there was slightly more dropped fruit from the unpruned palms than from the pruned palms. The difference was not significant statistically in any one year, but it was consistent enough to suggest that in the early stages of fruit growth there might have been enough more unrecorded drop on the unpruned palms than on the pruned palms to account for the difference. This early drop could have been produced by contact of bunches with leaves, much of it during tying down and bagging.

The data appear to indicate that there is a gradual reduction in the value of the older leaves for fruit production. If that is true, then a leaf-bunch ratio based on relatively young leaves is not equivalent to the same ratio on a palm carrying many old leaves. Yet data from the pruned palms in these experiments and observations on other palms that have not carried many more leaves, indicate relationships between leaves, bunches and fruit that may be somewhat helpful to the grower in deciding how much fruit to retain. Palms between 10 and 20 years of age, comparable as to size of leaves and with fruit moderately thinned on the bunch, have had ratios of 7 to 9 leaves per bunch after summer pruning without any reduction in number of inflorescences the following season. These leaf-bunch ratios were associated with yields of 3 to 4 pounds of fruit per leaf, including drop during harvest, but where soil or moisture conditions were unfavorable the maximum appeared to be lower.

Because of the variations in palms growing under different soil and cultural conditions it is again recommended that individual palm records of the number of flower clusters produced and bunches carried be kept from year to year. Individual palm yields can be checked fairly closely in this way and studied in relation to subsequent flowering and to pruning and cultural practices.

Table 3. — Average Number of Leaves per Bunch and Pounds of Fruit per Leaf in Relation to Inflorescences per Palm Appearing the Following Year.

TREATMENT	Wilson Garden			Peck Garden		
	Average number leaves per bunch	Average weight fruit per leaf (lbs.)	Average number of inflorescences following year	Average number leaves per bunch	Average weight fruit per leaf (lbs.)	Average number of inflorescences following year
1941						
Pruned	6.9	.. ..	10.9*	6.2	.. ..	13.7*
Unpruned	9.1	.. ..	14.5*	9.6	.. ..	16.6*
1942						
Pruned	12.6	1.9	15.3	9.5	2.1	14.4
Unpruned	12.7	1.7	15.9	10.9	1.7	14.5
1943						
Pruned	9.2	2.3	14.7	9.2	2.2	14.1
Unpruned	12.7	1.7	14.6	12.3	1.6	13.6
1944						
Pruned	7.0	3.0	15.0*	9.6	3.6	10.2
Unpruned	12.7	1.6	16.9*	15.1	2.3	9.9
1945						
Pruned	6.6	3.1	15.8*	9.9	(3.0)	12.6
Unpruned	10.9	1.8	17.4*	16.4	(1.8)	13.4
1946						
Pruned	6.6	4.1	13.4*	8.9	2.3	15.9
Unpruned	11.3	2.2	15.4*	12.6	1.3	16.1

* Difference statistically significant at 5% level.

Conclusions

The results of these experiments make it advisable to amend previous recommendations as to leaf pruning. Deglet Noor palms between 10 and 20 years of age, under favorable growing conditions, can carry too many leaves for maximum production of high quality fruit. It is probably undesirable to retain at any time more than 140 to 150 green leaves. In many gardens palms will not carry that many leaves. Palms over 20 years of age seldom carry that many under any conditions. In such cases it may be sufficient to

remove any leaves that begin to die if their midribs are below the lower end of the bunches as they hang. The minimum number of leaves that should be left cannot be fixed definitely because of other factors besides leaf-bunch or fruit-leaf ratio that limit the quantity and quality of fruit produced by the palm. Where blacknose is a serious problem it may be desirable to prune slightly higher than where it is not serious. The pruned palms in the Peck and Wilson gardens went through the checking and blacknose season (late June to mid-August) with about 120 leaves. With palms like these, instead of pruning in the middle of August just before bagging, it may be better to prune in June after the bunches are tied down. If such palms are pruned to about 120 leaves at that time, there should not be any more blacknose than has occurred on the pruned palms in these experiments, yet there would be more leaves available for food production during winter and spring.

RELATION OF TONNAGE AND QUALITY OF DATE FRUIT TO FERTILIZER AND WATER

Ted Carlson, Manager Crane Date Gardens, Indio, California

When I was asked to prepare a paper on this subject I didn't realize how complete and precise a rancher's records had to be in order that supporting and confirming data could be presented. While results from the Crane Date Gardens would seem to indicate that there is a direct relation between tonnage, quality, fertilizer and water, I find that our records are not complete enough for definite proof.

For instance, I find that it is impossible to say just how many acre feet of water were applied in each year. It is an easy matter to say just how many acre feet were pumped, but impossible to say just how many acre feet were applied to the actual date acreage. This is due to the fact that three pumps are used, two of which can and do feed into the same pipe lines. Some of this water is diverted to other crops such as vegetables, citrus and alfalfa. The Crane Date Gardens also has some eleven acres of so-called soft dates for which water from the same wells was used. We also have plantings of offshoots at all times which require water. While I believe that between twelve and sixteen acre feet were applied, I cannot definitely say.

As to how much more water was applied after my coming to the Crane Date Gardens. I again cannot say. All that I have to go by is the power bills for the years, and this proves practically nothing as some acreages of soft dates have been removed and the planting of some acreages of vegetables has been discontinued, since 1942. Therefore, I will have to assume from my knowledge of past practices that substantially more water has been applied.

For this report, I have taken the years from 1941 to and including 1946, and have considered only Deglet Noor dates. I assumed management in 1942, so have taken the one year prior to my management and carried out figures for the next five years. Another factor to be considered is that the ages of palms has increased, which means an increase in tonnage on some of the blocks that were not in full production in 1941. Following is a complete analysis of plantings and years of plantings:

1926	222
1927	462
1929	1432
1933	167
1936	192
1938	203
1939	163
1940	38
1941	30
Total	2909

As to approximate acreages, in 1941 and 1942 there were fifty-three acres, and from then on there were sixty-two acres of Deglets.

Total power bills were as follows:

1941	$2,645.31
1942	2,541.98
1943	2,613.03
1944	3,388.08
1945	3,178.85
1946	3,305.32

These figures mean practically nothing except for the fact that there was a slight increase in the total water used and there was a decrease in soft date and vegetable acreage.

Fertilizer used was as follows:

Prior to
1942: None or very small amounts of ammonium sulphate.
1942: 547 tons steer, or ten tons per acre. Vigoro 5½ lbs. per palm, and ammonium sulphate 3 lbs. per palm.
1943: 546.6 tons of steer, or 10 tons per acre. Vigoro 7 lbs.

Table 1. — Showing Year, Total Tonnage Delivered to Packing House, Tonnage per Acre, Tonnage per Palm, Tonnage of Each Grade and Culls.

YEAR	Tonnage Produced	Tonnage Per Acre	Tonnage Per Palm	Fancy	Choice	No. 1 Dry	No. 2 Dry	Culls
1941	390,631	7,558	157	875	233,781	19,192	104,214	32,569
1942	703,922	13,092	282	6,677	487,203	98,658	91,413	19,971
1943	562,738	9,076	124	14,634	298,688	170,552	30,731	48,133
1944	876,492	14,136	299	77,307	689,813	28,172	44,037	37,163
1945	247,237	3,987	84	15,175	129,438	31,926	19,710	50,988
1946	957,828	15,435	330	7,520	535,762	239,504	125,329	49,713

Table 2. — Results When Broken Down Into Percentages.

YEAR	FANCY (Percent)	CHOICE (Percent)	No. 1 DRY (Percent)	No. 2 DRY (Percent)	CULLS (Percent)
1941	.221	60.	4.9	26.	8.4
1942	.9	69.2	11.1	13.	5.
1943	2.6	52.7	30.3	5.	8.5
1944	8.8	78.7	3.5	5.	4.2
1945	6.1	52.3	12.9	7.9	20.6
1946	7.85	55.93	25.	13.08	5.19

per palm.

1944: 666.56 tons steer, or 10.7 tons per acre. Ammonium sulphate 5 lbs. per palm.

1945: 628.73 tons steer, or 10 tons per acre. Ammonium sulphate 5 lbs. per palm.

1946: 473.32 tons, or 7.71 tons per acre. Ammonium sulphate 10 lbs. per palm.

You will notice from these figures that beginning in 1942 and 1943 fertilizer applications were heavier than the following years. This was due to the fact that prior to 1942 very small amounts of commercial fertilizer had been used, and it was considered advisable to build up the garden. Again in 1946 the amount of steer fertilizer was decreased and commercial was heavier. This change was made as the cost of steer had been raised substantially, while the cost of commercial fertilizer was practically the same.

For production and quality, Table I is a chart giving year, total tonnage delivered to the packing house, tonnage per acre, tonnage per palm, tonnage of each grade and culls.

In the year 1943 we had a very poor pollination which accounts for the drastic drop in tonnage. Again in 1945 we had a rain which accounted for the reduction. All of these figures are for dates delivered to the packing house, and no accounting is made of culls on the ground. Table 2 shows the results broken down into percentages.

These are the figures which tell the results of six years operations. I cannot tell you definitely that if you apply so much water and so much fertilizer you will raise so many pounds of dates of such and such a quality. However, it would seem that the program at the Crane Date Gardens was a sound one and at least presents a basis for future planning. We as producers must continue our own experiments to augment those of trained research specialists that are in the field attempting to find the answers to these problems. It means a long term project, and I am sure that the agencies conducting these experiments will welcome any information available from ranchers.

SUGGESTIONS FOR IMPROVEMENT IN DATE PACKING PLANT SANITATION

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INTRODUCTION

The trend in the date packing industry, as well as with other dried fruits (figs and prunes in particular), is toward the marketing of fruit with higher moisture content because of the improved palatability, texture and general appearance which results in more favorable consumer acceptance.

Probably the most important and, in any event, one essentially mandatory requirement involved in this new development is improvement in packing plant sanitation.

The modern concept of adequate plant sanitation takes into account protection of the public from the more abstract offenses against man's discriminatory or esthetic senses as well as protection from specific health hazards. State and federal regulations (*) governing minimum requirements for sanitation in food production plants have been prepared to conform to this concept. These regulations have refocused attention on food plant sanitation; particular attention having been paid to prevention of contamination of foods by foreign matter (filth) and to the general aspects of good housekeeping.

The establishment of an adequate sanitation program for the date packing industry involves consideration of several basic requirements: those which pertain to matters of personal hygiene and public health of all personnel; those which govern prevention of contamination of the dates by foreign matter (filth); and those which involve the general requirements for good housekeeping in and about the plants.

In any sanitation program it is necessary to evaluate the relative level of quality and to determine the factors which may be responsible for depressing that level below an acceptable high standard of sanitation. This evaluation is accomplished first by making sanitary surveys and then, as a result of the information gathered, deciding which factors may need immediate attention. As indicated by previous investigations (Mrak, Phaff and Vaughn, 1942; Mrak and Stadtman, 1946; and others) effective control of micro-organisms is essential in the packing of superior quality California dates. Effective control of microorganisms requires a high level of sanitation. It is the purpose of this paper to discuss some of the factors under investigation which have an important bearing on the effective control of micro-organisms in the date packing industry. Only those improvements which may be accomplished reasonably and economically or have a direct bearing on imperative changes will receive attention at present. Matters of personal hygiene and public health, prevention of contamination by foreign matter (filth) and good housekeeping will be discussed in that order.

Matters of Personal Hygiene and Public Health Pertaining to All Personnel

Intelligent, interested and energetic supervision will keep the plant at a satisfactorily high level of sanitation at all times, if the fundamental requirements are provided, regardless of the state of repair and looks of the buildings themselves.

All requirements are not only essential but mandatory since there are local, state and federal legal specifications which require the maintenance of a minimum standard of sanitation. However, mere maintenance of a minimum standard is not enough in the case of date packing. Dates are very perishable. If the trend continues toward marketing of dates with higher moisture content, the perishability will be magnified in proportion to the increase in moisture. Since the majority of dates are packaged by hand it is obvious why it is important to give more than minimum attention to matters of personal hygiene and public health of all personnel.

There are several mandatory essentials which must be provided to maintain a satisfactory level of personal hygiene and public health. These include:

1. Supervision of the plant water supply.
2. Supervision of the disposal of sanitary and industrial wastes.
3. Maintenance of sanitary facilities within the plant (toilets, rest rooms, wash rooms, etc.)

(*) Federal Food, Drug and Cosmetics Act, 1938 and the California Pure Foods Act, 1939.

4. Supervision of dress, habits and state of health of all personnel.

5. Supervision of lighting, ventilation and heating insofar as these factors relate to public health or are involved in other aspects of plant sanitation.

6. Provision for establishment of employer-employee educational programs to acquaint *all* personnel with complexities involved in maintaining a high level of plant sanitation.

WATER SUPPLY: The supply of water for drinking as well as use in operations concerned with the packing of dates should satisfy the standards of the U. S. Public Health Service. If the source of water is on packing house premises precautions should be taken to prevent its contamination. Control tests should be made at regular intervals, regardless of the source.

If an untreated fire protection water supply also is maintained, extreme care must be given to protection of the drinking water against cross connection with the unsafe water.

Drinking fountains should be of the angle-jet type which prevents return of the water in the jet or orifice. The jet orifice should be above the edge of the bowl to prevent contamination if the drain becomes clogged. About 20 to 25 gallons per person per working day should be available for drinking, washing and other purposes. In addition, the supply should be sufficient to provide full volume at times of peak usage during clean-up and other operations connected with date packing.

Toilet, Wash Room and Related Facilities: Toilet rooms, wash rooms, rest rooms and locker rooms should be so located that they are apart from the room or rooms where dates are being stored, processed or packed. (Location, construction and installation of separate toilet facilities for each sex should conform to local and state regulations.)

The toilet rooms should be fitted with self-closing doors which should not open directly into work rooms. Windows should open to the outside and be screened. If there are not enough windows to provide for sufficient natural illumination, artificial lighting should be installed in an amount great enough to encourage cleanliness. In the complete absence of windows, separate ventilation systems should be installed.

Floors of toilet and wash rooms should be of some reasonably waterproof material (concrete, tile, etc.) with a rounded base of the same material extending six inches to one foot up the wall. The floors, sidewalls and ceilings should be of a finish which is readily cleaned.

Cubicle partitions for each toilet stool should provide privacy but at the same time not meet the floor or ceiling to promote easy cleaning and provide adequate ventilation.

A requirement of the State of California labor code states that "whenever five or more of the employees are of different sexes a sufficient number of separate water closets or privies shall be provided for each sex." The number of individual toilets required depends upon the number of employees. The American Standards Association, New York, has recommended the following:

Number of Employees	Minimum Number of Toilets
1 to 9	1
10 to 24	2
25 to 49	3
50 to 100	5
More than 100	1 for each additional 30 individuals

In the case of installations for male personnel, when urinals are installed, one less than the above number of toilets may be provided if the number of urinals is not reduced to less than two-thirds of the toilets. Urinals should always be installed in the toilet rooms to prevent soiling of seat fixtures.

Adequate washing facilities are of utmost importance for the date industry because of the amount of hand labor involved in sorting and packing the dates and other products.

Construction of wash and locker rooms should conform to the specifications for toilet rooms. Wash and locker rooms may be combined and be located adjacent to the toilet rooms for the greatest convenience and utility.

One washing faucet should be provided for each 10 employees in the largest plants. This ratio should be increased to one washing faucet for every 5 employees in the intermediate and small plants. The washing faucet is recommended as being far more sanitary than the conventional lavatory or wash basin because it is much less likely to be involved in the spread of infections among the users. Treadle water valves should be installed on all wash faucets. Liquid soap in dispensers and disposable towels should be placed at every wash faucet.

Rest rooms should be provided when ten or more women are employed. The rest rooms should be separate from but adjacent to the wash rooms. A minimum of 60 square feet of floor area should be provided for the first 10 with two additional feet provided for each additional woman employed. At least one couch or bed should be available in the rest room.

Unless smoking is restricted to rest rooms, locker rooms or wash rooms specific smoking areas away from product preparation, packing or storage areas, should be established in each plant. Management should make available the necessary accessories as large ash trays, drinking fountains, benches, etc., and then *insist that smoking be confined to the specified areas.*

It is of utmost importance that the janitors be made responsible for the condition of the toilet rooms, wash rooms, smoking areas, etc., if they are to be kept clean and neat. There should be an abundance of liquid soap, disposable towels and paper available at all times. Management should make frequent inspections of the rooms to insure efficient janitorial service.

Space in the plant should also be provided where employees are permitted to eat their lunches. A covered receptacle must be available to receive all waste food, paper, etc.

Uniform Clothing: Clean clothing, footwear and adequate headgear should be worn by all employees. It is suggested that the date packing plants encourage the wearing of uniforms and headgear by furnishing them at reduced cost and providing for laundry at regular intervals. Such a program would do much to insure wearing of safe, sanitary clothing at all times. Management should insist that headgear be worn by all workers (male and female) handling dates to prevent contamination of the dates with human hair.

Clean, uniform clothing and headgear aids in the general appearance of the plant and fosters an attitude of cleanliness among the personnel.

Waste Disposal: In the absence of a municipal waste disposal system into which the plant wastes may be discharged it is the obligation of the plant to dispose of its sanitary and industrial wastes without the creation of a hazard or nuisance to the public.

The sanitary and industrial wastes must be segregated. The sanitary wastes must be disposed of in a septic tank or other satisfactory system. (*) It is recommended that the industrial wastes be disposed of by a system of intermittent irrigation on land to avoid mosquito and odor nuisances which are difficult to control if the wastes are lagooned.

Good Housekeeping

Good housekeeping practices are intimately concerned with almost all

(*) Ehlers, V. M. and Steel, E. N., Municipal and Rural Sanitation, 3rd edition, 1943, McGraw-Hill Book Co., N. Y.

phases of sanitation in the date packing houses. They are especially important in connection with the prevention of contamination of the products with foreign matter (filth).

It therefore is obvious that the personnel charged with keeping the plant and surroundings clean, neat and free from objectionable accumulations have an important and exacting responsibility. Such responsibility requires intelligent, alert, interested, energetic supervision. With adequate supervision and a selected clean-up crew it is a relatively simple task to keep the plant and surroundings clean and neat at all times.

The clean-up personnel must be well organized and integrated with the janitorial service which customarily is charged with keeping offices, toilets, rest rooms, etc. clean and neat. The special function of the clean-up crew should be to keep plant areas and equipment involved in actual handling and processing of dates and by-products at a high level of sanitation.

In the date packing industry particular attention should be given to the following:

1. Prevention of accumulations of dates which have dropped onto and about the receiving platforms and floors in the plants.

2. Prevention of accumulations of unprotected dates in trays and boxes in free floor space of the packing room during rush seasons when there is too great an inflow of fruit for the processing lines to handle. Warehousing or better control over harvesting is necessary to handle this problem.

3. Prevention of accumulations of dirt and debris on stand-by equipment or equipment which may be used seasonally. (In the case of the latter it should be the duty of the clean-up crew to thoroughly clean and otherwise protect the equipment immediately after final seasonal use before storage.)

5. Prevention of accumulations of dust and other debris on walls, ceilings, rafters and other out-of-the-way places in the plant.

6. Prevention of indiscriminate accumulations of packaging materials, broken lugs, flats, etc. in the plants or about the premises.

7. Prevention of accumulations of tall grass, brush, weeds, etc. about the premises.

Every effort should be expended to keep the floors free from smashed dates, date particles, and other materials used in packaging, processing or preparing dates or date by-products. Care should be especially directed to the cleaning of the dry-cleaner or wet-washer equipment, conveyor belts, packing table surfaces, etc.

If these requirements are met much will have been accomplished toward control of insect and rodent populations which otherwise may find food and harborage and, as a result, regularly infest the plant. Also, a clean, neat plant and surroundings will always be available for inspection by a critical public.

Insect and Rodent Control

The presence of insects and rodents in any food or beverage plant is very objectionable evidence of improper sanitation; particularly rats, mice, cockroaches and flies (house or stable) because they are proven and well-publicized carriers of disease-producing micro-organisms and filth. Aversion toward other flies and insects commonly found in and about food plants is exhibited by many people although these latter insects, in the present state of our knowledge at least, are less important as real health hazards than for esthetic reasons.

Rodents habitually lick themselves and, as a result swallow hairs. These injested hairs reappear in the feces. Rodents also urinate frequently and indiscriminately. Rodent hairs are easily detected and identified by microscopical techniques. Rodent urine is easily detected by use of ultra-violet light. It is therefore obvious why rodent hairs and body wastes (feces and urine) are used by regulatory agencies as proof of evidence of rodent contamination.

Whole or identifiable insect and larvae fragments, eggs, gut discharges, etc. are also readily detected and identified by regulatory agencies and are used as proof of evidence of insect contamination.

Control of Insects: As already indicated adequate sanitation probably is the most important single factor involved in the control of insects. Large numbers of flies or cockroaches in or about the plant are indicators of the presence of unprotected toilets, fermenting waste piles, etc. which provide food and breeding places. In addition the plant may be a focal point for bees, wasps, fruit flies, dried fruits insects, etc., which find food and breeding places in unprotected fresh or processed dates and piles of fermenting date residues.

The larger flying insects as flies, bees, wasps, etc.. which may be attracted to the plant for various reasons may be kept out by adequate screening. Screening is required by the State of California Food Sanitation Act, which reads: *"The doors, windows and other openings of every food producing or distributing establishment, where practicable, shall be fitted with stationary or self-closing screen doors and wire window screens, of not coarser than fourteen mesh wire gauze."*

Temporary control of insects may be obtained by use of attractants and poisons as well as fumigants. The latter are indispensable to destroy active infestation of the freshly picked dates. Nonetheless, any chemical control must be considered temporary and must be used as a temporary measure with the firm understanding that such treatment must be repeated at frequent intervals as needed to control reinfestation.

Since insect poisons frequently are a source of dangerous contamination of food, they must be used by persons who respect and understand that they are poisons and also understand their use. *Furthermore, unless the residual left on the finished product conforms or can be made to conform to state and federal regulations concerning toxic residues, insect poisons must never be used, either in the plants or in the date gardens.*

A program which will materially aid in the effective control of insects in the date industry must include the following measures:

(1) Control of insect infestation in the date gardens by destruction or removal of all dropped cull dates and other means including treatment with approved chemicals.

(2) The customary fumigation prior to and after packing or during storage.

(3) Scrupulous housekeeping in and about the plants to insure the removal of all date debris which may serve as food or harborage for insects.

Control of Rodents: The first steps in a successful, permanent control program for rodents involves *concurrent* elimination of food and shelter, for if either food or shelter is lacking the rodent populations will move to some other place providing these essential requirements in order to maintain themselves.

Elimination of food for rodents (as well as insects) is but one step in good housekeeping. Therefore it is necessary to eliminate all accumulations of unprotected dates or date refuse, improperly cleaned floors and equipment carrying date debris, lunch scraps, open garbage containers, etc.

Elimination of shelter out of doors must include removal or destruction of all accumulated piles of date refuse (which may furnish both food and shelter) other refuse including broken lumber, etc. that has not been moved for a long time and weeds, grass and brush on the premises which have been allowed to

grow without any cutting.

Elimination of shelter within the plant must mean "rodent-proofing" or the absolute exclusion of rodents by preventing their entry into the plant. "Rodent-proofing" must control mice as well as rats, so it is necessary to close all openings which may serve as entryways to at least one-fourth inch. Because of the different habits of rats and mice prevention of entrance from sewers, sumps, defective floors, etc., as well as walls, ceilings and roofs is required.

Because it may not be possible to "rodent-proof" a plant all at one time or may not be practical for one reason or another, temporary control measures may have to be used. These include the use of traps, poisons and fumigants. Continuous surveillance is required even with a "rodent-proof" plant, as there may be certain unavoidable means of entry, such as through an open door or in raw materials.

Bats, barn owls, pigeons and other birds which frequently enter unprotected plants will be excluded when the plants are rodent-proofed and screened against insects. Pets (dogs, cats, fowls) should never be allowed in the plants.

The most important feature of temporary control is the selection of the control man. He may be a permanent employee or a commercial exterminator. To be successful, however, he must have the necessary "know-how" and equipment and be interested and energetic.

Protection of Product Ingredients: Several date products require the use of sugar syrups, citrus products, nuts and certain cereal products. In the event that these dry, product ingredients are subject to contamination by rodents or infestation by insects, special storage facilities should be provided until the plants have complete protection against entry of insects and rodents. In most of the plants one or more fumigation chambers could be designated for storage of these products. In others, a special combination fumigation-storage room could be constructed.

Control of Microbial Contamination

It is necessary to give considerable attention to the problem of adequate control of micro-organisms because of the susceptibility of dates to fermentation, molding and souring. If the trend toward the production of dates of higher moisture continues very rigid control measures will be required throughout the industry for susceptibility to spoilage is proportional to the moisture content of dates.

In the date packing operations two major sources of contamination must be controlled: contaminated field-run dates entering the plants and continued use of contaminated packing equipment.

Supervision of Picking: Control of the contamination naturally found on dates in the field is not easy. Every precaution must be taken to use care in picking and handling the dates in the field. Clean field boxes should be mandatory for a minimum of field dirt is essential to successful control once the dates are delivered to the packing plant.

Picking should be supervised to such an extent that a minimum of moldy and otherwise spoiled dates are gathered.

The picking operations should be so synchronized with the packing operations that field-run dates are fumigated within the day the picking is done. This is important to control the spread of spoilage micro-organisms by insects as well as to control the insect populations.

Control in the Packing Plants: In the packing plants the sources of possible microbial contamination are such that constant surveillance of all steps is required.

Special efforts should be made to insure a uniformly high level of personal hygiene among the workers because of the hand labor involved in packing dates and the difficulties encountered in control of the "human factor." This can be accomplished only by provision of the necessary sanitary facilities and creation of incentive through intelligent instruction and example as already stressed.

Cleaning of equipment is essential to prevent excessive contamination of all dates passing through wet-washers, dry-cleaners, and over inspection belts, packing tables, etc. Unless this cleaning is done and done well, the packaged dates all will become uniformly and frequently heavily contaminated with micro-organisms which may cause spoilage.

a. Use of Water: Improper use of a good water supply may be responsible for large increases in the microbial population of dates when:

1. Wet-washer water is recirculated.
2. Static or semi-static water is used in tanks for continuous belt-washing.
3. Static water is used in pails for dampening hand cloths of the packers.

The data in Table 1 illustrates the necessity for control of the use of water. (Also consult Table 3). It is clear that recirculation causes an accumulation of micro-organisms in the wash waters. At the same time there is an undesirable accumulation of field dirt and other debris in the water. It is probable therefore that the wet-washer is just as great a source of contamination as the dry-cleaner unless the method of operation of the wet-washer is changed to eliminate static or semi-static water in the wash tank. The same reasoning is applicable with the use of water in the continuous belt washer. If heavy re-contamination can be prevented, the advantageous time-saving of the date wet-washer and the continuous belt washer is highly desirable.

Table 1. — The effect of recirculation on the microbial count of wash water used on dates.*

SAMPLE	Tatal micro-arganisms per cc.**
Plant A wet-washer water 1/6/47	1,500,000
Plant A wet-washer water 1/7/47	8,000,000
Plant B belt washer water 1/6/47	1,500,000

*Cantinuaus recirculatian far duratian af shift.

**Caunts made in the usual manner with tryptane glucase bramcresal purple agar (NCA farmula), a Difco praduct. The caunts include bacteria, malds and yeasts.

b. Equipment Contamination: Excessive re-contamination of dates also may occur through contact with equipment surfaces, many of which carry large populations of micro-organisms as is shown in table 2. It

Table 2. — Equipment Surface Contamination in the Date Industry.

SURFACE TESTED	Canditian af Surface	Tatal micra-arganisms per 4 sq. inches af Surface *
Wet-washer canveyar belt	moist	820,000
Same belt after rautine cleaning	maist	530,000
Canveyar belt with cantinuaus washer	Wet	880,000
Packing belt far hydrated dates	maist and sticky	150,000
Packing table far natural dates	dry and sticky	2,000
Grading belt	dry and very dusty	15,000
Date rall belt	dry	500

* Viable caunts made with tryptane glucase bramcresal purple agar (NCA farmula), a Difca praduct, accarding ta the methad af Vaughn and Stadtman, 1945. The caunts include bacteria, malds and yeasts.

is to be noted that the amount of moisture carried on the surface has an important bearing on the surface populations. Thus, the dry belts have low counts; their individual populations apparently depending upon the accumulation of viable cells and spores along with dust and other debris.

It is obvious from examination of the data presented in the preceding tables that accepted methods for good housekeeping do not necessarily provide for adequate control of micro-organisms. There is increasing evidence that continuous sanitizing with some accepted chemical is necessary. Continuous sanitizing of belts and packers cloths is particularly desirable in the date industry. However, the addition of a sanitizing chemical does not necessarily provide continuous control of micro-organisms. *That this is true is evidenced by the fact that the recirculated waters referred to in Table 1 had been treated with sanitizing chemicals.* On the other hand, addition of sanitizing chemicals to a wash water can provide control of microbial contamination as shown in Table 3. Further improvement

Table 3.—The Effect of Addition of a Sanitizing Chemical on Microbial Contamination of Wash Water and Hand Cloths.

SAMPLE	Tatal Micra-Organisms(1) Na additian	Additians(2)
Wash water from cutters & packers buckets	85,000 per cc.	85 per cc.
Wash water fram by-products kitchen buckets	104,000,000 per cc.	0
Cutters and packers hand claths(3)	400,000,000 per sq. in. (naturals)(4)	150,000 per sq. in. (hydrated) 9,600 per sq. in. (naturals)

1. Viable caunts made in the usual manner (table 1).

2. Three ounces of "stabilized" hypochlorite powder per twa gallons af water. Counts made on samples taken 2 hours after additian. The treated water was used far 2 hours anly and then discarded.

3. One square inch of clath was cut aseptically from the hand cloth and shaken in a 100 ml water blank with added $Na_2S_2O_3$.

4. Data from Mrak and Stadtman, 1946.

in control of the microbial contaminations of the hand cloths used by workers can be made by more frequent changes of treated water in the wash buckets used to keep the hand cloths damp. Similarly, the water used in the wet-washers and the continuous belt washers can be treated to control the excessive populations of micro-organisms.

It should be stressed and restressed that inadequate use of chemical sanitizing compounds is not only inefficient and uneconomical but frequently contributes a false sense of security to the user.

Summary

The problem of improvement of date packing plant sanitation has been discussed from the standpoint of those improvements which may be accomplished reasonably and economically or have a direct bearing on imperative changes. These include matters of personal hygiene and public health pertaining to all personnel; prevention of contamination by foreign matter (filth) and general good housekeeping.

The prevention of contamination of dates by micro-organisms which may accumulate in or on equipment during processing has been discussed in detail. The success of the trend toward packaging "high moisture" dates depends to a great extent upon control of micro-organisms which may cause fermentation, molding or souring. The use of wet-washers for cleaning dates and continuous belt washers are improvements in date packing which are desirable. However, further research on use of water and sanitizing chemicals with these devices is indicated from the data presented herein.

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SYMPOSIUM - - GROWING QUALITY DATES

Moderated by William Cook and Ted Carlson

WILLIAM COOK opened the symposium with the following remarks: In 1912 Fred Johnson had four date trees; these trees composed the entire production of dates in Coachella Valley with the exception of those grown at the U. S. Government Date Garden. The dates were picked practically every morning; all of the dates were sold at $1.00 a pound and orders for them were placed three years in advance.

Today we have 150,000 date palm trees in Coachella Valley. The packing houses are over-crowded. Dates frequently have to be put into cold storage when they are brought in. Sometimes they stand for ten days with nothing but a preliminary fumigation treatment. Now we pick them once a month, mayhe. Harvesting is put on a straight piece work proposition. Good picking foremen are very difficult to find inasmuch as a great deal of experience as well as conscientiousness is required. He looks after the men, tallies their work and polices the job.

That summarizes some of the difficulties; however, to get back to general cultural practices, there has been a decrease in average quality in specific grade, palatability, flavor, and appearance. The grower lacks uniformity in the grade of the fruit, and there has been a great deal of increase in the percentage of culls. Growers and packers all admit that the general quality is not what it might be. One interesting fact brought out by Ted Carlson's talk was that every ranch is a different situation. A ranch that produced top quality dates ten years ago may not produce as good quality dates today while other ranches that produced poor quality dates ten years ago are now improving the quality of their dates. The factors that caused the decrease in the quality of dates produced by many ranches were the scarcity of labor during the war. other war-time problems and not being able to maintain high standards of production. The ranchers who had poor quality dates ten years ago are now willing to devote more time to improving their dates. Then, too, the Department of Agriculture men have given help and advice to the owners of the poorer gardens.

Here are some figures that I want to talk about; these are the total production figures of the California Date Growers' Association, that is, the total pack-out figures for the ten-year period, 1937-1946. The culls referred to are those sold from the packing house but do not include field culls.

PACK-OUT RECORDS
of the
California Date Growers' Ass'n

Year	Total Weight (in lbs.)	Fancy Dates (%)	Selected Dates (%)	Culls (%)
1937	1,925,107	3.2	25.7	3.3
1938	1,801,536	3.5	23.0	2.4
1939	1,607,873	2.0	22.2	28.7
1940	3,488,964	10.5	22.3	2.4
1941	3,133,867	5.2	10.1	14.7
1942	3,947,378	4.2	27.0	4.7
1943	4,900,939	1.2	19.4	12.5
1944	6,140,441	2.4	16.0	9.4
1945	2,854,272	2.0	30.9	26.5
1946	6,557,871	7.8	29.1	8.2

This chart shows that we are producing more cull dates, as the years pass, over and above the influence of climatic conditions.

It is apparent that we must institute better growing practices, packing and packing house operations. We have to produce dates that the buyer wants and yet have to operate on a reasonable and economically sound basis; otherwise, the average return on the whole crop is reduced. Nevertheless, it isn't a good practice to create a multitude of grades just because customers want them.

There is also the matter of picking. I want to give you an idea that was developed by Dr. Roy Smith, U.C.L.A., working with growers and pickers of Ventura County citrus. They had tried many plans regarding the rate of pay for pickers. Finally it developed that they would pay a flat amount per hour (around 30c) and a sliding-scale rate per box so that as they picked more boxes per tree they would get less per box because they picked and totalled more boxes per hour. Perhaps that would be a good method for the date industry. A payment should be made to the pickers that will be a little sounder and that will give us a little better work.

In conclusion. I propose the following ten recommendations for producing hetter quality dates:

1. Irrigate bountifully in spring and early summer and not too much in July.

2. Thin your dates in a manner to give you uniformity of size and maximum number of dates that can be grown in keeping with best horticultural practices.

3. Reduce interval between pickings to 7 to 14 days.

4. Select hest possible picking foreman. Be sure that he is acquainted with the packing house manager and in contact with him and working with him during the season.

5. Demand real supervision by that foreman seeing that he supervises not over 15 men.

6. Develop a fair method of payment to pickers that does not place a premium on poor work or a premium on waiting to pick a bunch until all the dates on it are ripe.

7. Do not deliver dates that have been picked up off the ground—put them in the cull box.

8. Reduce the period of time between pickings of fruit and first grading of fruit in packing house.

9. Set up and support a realistic marketing and advertising program keyed to the facts of the volume and type of production.

10. Review and improve grading procedures, grading specifications and terminology.

BERT CAVANAGH was asked to add a few remarks on methods of picking: Fifteen or twenty years ago picking was on entirely different basis. There were fewer dates to handle, pick, and harvest. At that time quality was much better than it is now. Picking was usually on a day-wage basis. The interval between picking was between a week and two weeks. Output of average pickers was normally between 300 and 400 pounds in a 9-hour day. Loss due to dates on ground was far less than it is now. Quality as it came out of the packing house was much better. Last season I was visiting one of our ranches when the picking season started. One picker I was watching seemed to be in a terrible rush to get through the bunch of dates so that the dates were popping off and nearly covering a 30-foot circle. There is rather a large loss due to this type of picking. As for the picking foreman, I think he is of the utmost importance. He should have quite a bit of training to qualify him for the job and is not qualified for the job with only one year's experience. The crew he can handle should not exceed 12 to 15 men. I also feel that the packing practices have a great deal to do with the quality of dates we are producing.

BILL DOLLINS was then called

upon to speak on the subject of thinning: He indicated that thinning is very important in growing quality dates. Concerning the picking foreman, he should be a man who will oversee his men because if they cut off too many strands blacknose or other damage may result. There is no rule of thumb concerning this. You just have to have a man who knows his dates. As for the number of bunches to leave on a tree, it depends upon the ranch; usually 13 or 14 bunches with 30 or 40 strands on an average tree. I cut the tips off when I pollinate but don't think it advisable to cut it out before pollinating. In order to avoid the extra labor, it is my general practice to knock out the centers when pollinating. If you wait until the middle of the saeson, you might injure the bunch. I don't quite trust the usual run of laborers to use their judgment in knocking out the centers. Of course, the earlier you thin the bunch, the sooner you get an effect on the size of the dates. The greatest trouble is the lack of adequate supervision. If you are going to get uniform dates you must follow uniform thinning. Too much variation results in culls and blacknose.

TED CARLSON added a few remarks concerning date bunch thinning: The Crane Ranch cuts the heart out of the bunch during the pollinating. An added reason for doing this is that we thin rather late. about the time of the June drop. It works fairly successfully for us, and results in better dates.

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Paul F. Smead ..... Indio
Sniffs' Date Garden ..... India
Leonhardt Swingle ..... Indio

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